

Ontario
Certified Crop Adviser

Performance Objectives

Seventh Edition
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Contents

Contents	ii
Introduction.....	iii
Section 1: Nutrient Management.....	1
Competency Area NM-1. Basic Soil Fertility Concepts	1
Competency Area NM-2. Soil Testing, Plant and Manure Analysis	1
Competency Area NM-3. Liming and pH.....	2
Competency Area NM-4. Fertilizer Placement	2
Competency Area NM-5. Nitrogen	2
Competency Area NM-6. Phosphorus.....	2
Competency Area NM-7. Potassium.....	3
Competency Area NM-8. Secondary and Micronutrients	3
Nutrient Management References	4
Section 2: Soil And Water Quality	5
Competency Area SWQ-1. Water Cycle and Soil Drainage	5
Competency Area SWQ-2 Water Quality	5
Competency Area SWQ-3. Organic Nutrient Sources (Manures, Biosolids, and other Wastes)	5
Competency Area SWQ-4. Soil Quality	6
Competency Area SWQ-5. Soil and Water Conservation Practices	6
Soil and Water Quality References	6
Section 3: Integrated Pest Management	8
Competency Area IPM-1. Principles and Practices	8
Competency Area IPM-2. Weed Management	8
Competency Area IPM-3. Disease and Nematode Management	9
Competency Area IPM-4. Insect, Mite and Slug Management.....	10
Competency Area IPM-5. Pesticide Resistance Management	10
Competency Area IPM-6. Pesticide Stewardship & the Environment.....	11
Integrated Pest Management References.....	11
Section 4: Crop Management.....	12
Competency Area CM-1. Crop Adaptation.....	12
Competency Area CM-2. Seed Quality	12
Competency Area CM-3. Crop Growth And Development Staging.....	12
Competency Area CM-4. Tillage Systems.....	13
Competency Area CM-5. Seeding Factors.....	13
Competency Area CM-6. Crop Utilization and Harvesting Quality	13
Competency Area CM-7. Cropping Systems	14
Competency Area CM-8. Safe Storage And Quality	14
Competency Area CM-9. Economics.....	14
Competency Area CM-10. Regulatory.....	14
Crop Management References	15

Introduction

The purpose of this booklet is to be a guide to help you prepare for the Ontario Certified Crop Adviser Examination. The performance objectives outline the knowledge and skills that are needed in order to provide sound advice to crop producers.

To become a Certified Crop Adviser (CCA) in Ontario, it is necessary to pass two exams. The first is the International exam, whose performance objectives is set by the American Society of Agronomy and is available in a separate booklet. The second is the Ontario CCA Examination, whose performance objectives are described in this booklet. The exam consists of 120 multiple choice questions. The subject matter is divided into four sections. The percentage of exam questions under each section (weighting) will be as follows:

1.	Nutrient Management	25%
2.	Soil and Water Quality	20%
3.	Integrated Pest Management	25%
4.	Crop Management	30%

Each of the four sections is broken down into competency areas with specific performance objectives. In preparing for the exam, you can best allocate your time by focusing on areas where your knowledge is weakest relative to what is described in the performance objectives.

These performance objectives were developed by the Ontario Certified Crop Adviser Exam Committee and approved by the Ontario Certified Crop Adviser Board. We wish to acknowledge those who contributed to the development of the first edition and the revisions for the second edition. Many people involved in crop advising, university faculty and government staff have been involved in the development and review of the performance objectives. The following people were involved in the review and updating of recent editions of the performance objectives:

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We invite and encourage you to show your professionalism, integrity and pride. Agriculture - like medicine and law - relies on expertise, information and skill. The CCA designation identifies people who care about their profession and the success of their customers.

Section 1: Nutrient Management

Competency Area NM-1. Basic Soil Fertility Concepts

1. Describe the roles of nitrogen, phosphorus, potassium and magnesium in plants.
2. Define base saturation.
3. Describe the influence of soil pH, clay content and organic matter content on cation exchange capacity and base saturation.
4. Describe the difference between an estimated value for cation exchange capacity and an actual determination.
5. Define guaranteed analysis as outlined in the Fertilizers Act of Canada.

Competency Area NM-2. Soil Testing, Plant and Manure Analysis

6. Describe the soil sampling procedures recommended in the Agronomy Guide for Field Crops, OMAFRA Publication 811.
7. Describe methods used for site specific/intensive soil sampling and list their advantages and disadvantages.
8. Describe the tissue sampling procedures recommended in OMAFRA Publication 811 for corn, soybeans, winter wheat and alfalfa.
9. List advantages and disadvantages of the following three fertilizer recommendation approaches:
 - a. cation saturation ratio
 - b. nutrient build-up & maintenance
 - c. nutrient sufficiency
10. Identify the approach used in the fertilizer recommendations in OMAFRA Publication 811.
11. Distinguish between extractable amount and total amount of a nutrient in a soil.
12. List nutrients for which there are soil tests accredited by the Ontario Soil Management Research and Services Committee as stated in OMAFRA Publication 811.
13. Identify soil test extractants accredited for making fertilizer recommendations by the Ontario Soil Management Research and Services Committee as stated in OMAFRA Publication 811.
14. Identify the limitations of using a non accredited soil test for the following nutrients: phosphorus, sulfur, boron, calcium, copper, chlorine, iron, and molybdenum.
15. Interpret the information given on an accredited soil testing laboratory report.
16. Calculate the amounts and rates of fertilizer needed to meet specific soil test recommendations.
17. Describe the role of soil testing, plant tissue testing and visual plant symptoms in a fertilization program.
18. Describe the different forms of nitrogen found on a manure analysis report.
19. Calculate the credits for N, P and K from manure in the year of application and subsequent years, based on an analytical report.
20. Describe how nutrient credits from animal manures, compost, biosolids and legumes influence fertilizer recommendations.

Competency Area NM-3. Liming and pH

21. Define calcareous soil.
22. Describe the influence of the following factors on soil pH: slope position, parent material, texture.
23. Describe the advantages of proper lime incorporation.
24. Distinguish between soil pH and buffer pH.
25. Describe how the recommended Ontario soil test (OMAFRA Publication 811) uses soil pH and buffer pH to determine soil lime requirements.
26. Based on OMAFRA Publication 811, define neutralizing value, fineness rating and Agricultural Index of liming materials.
27. Calculate lime application rates using an accredited soil testing report and the neutralizing value and fineness rating of the liming material.
28. Determine when to use dolomitic versus calcitic lime to correct soil pH.
29. List recommended soil pH ranges for: corn, soybeans, wheat, barley, and alfalfa.

Competency Area NM-4. Fertilizer Placement

28. Rank the relative toxicity to corn, wheat and soybean seedlings of fertilizer materials.
29. Identify factors affecting the amount of fertilizer that can safely be applied in a band near the seed.
30. Identify safe limits for seed placed fertilizer for corn, soybeans, wheat, canola, and cereals.

Competency Area NM-5. Nitrogen

31. Identify how nitrogen is gained, lost and transformed in the soil through mineralization, nitrification, volatilization, fixation and leaching.
32. Describe how nitrogen gains, losses and transformations in the soil influence nitrogen availability to plants and nitrogen fertilization practices.
33. Describe the advantages and limitations of the soil nitrate-nitrogen test for corn and barley.
34. Describe how topography can influence soil nitrate levels.
35. Recognize nitrogen deficiency symptoms on corn, soybeans, alfalfa and cereals.
36. Describe the agronomic advantages and disadvantages of each of the following fertilizer materials in corn, winter wheat, and forage production:

anhydrous ammonia	ammonium nitrate
urea-ammonium nitrate (UAN)	calcium ammonium nitrate
urea	ammonium sulfate

Competency Area NM-6. Phosphorus

37. Describe how soil chemical properties affect phosphorus availability (labile and non-labile) and mobility in the soil.
38. Describe the advantages and disadvantages of seed-placed, banded and broadcast fertilizer phosphorus placement methods.
39. Recognize phosphorus deficiency symptoms on corn, soybeans, alfalfa and cereals.
40. Describe the agronomic advantages and disadvantages of each of the following fertilizer materials in corn, winter wheat, and forage production:

triple superphosphate
diammonium phosphate

monoammonium phosphate
liquid phosphorus (ammonium polyphosphate) fertilizers

Competency Area NM-7. Potassium

41. Describe how soil chemical and physical properties affect potassium fertilizer availability, mobility and leaching.
42. Recognize potassium deficiency symptoms on corn, soybeans, alfalfa and cereals.
43. Recognize potassium luxury consumption and its potential effect on forage quality for ruminant livestock.
44. Describe the agronomic advantages and disadvantages of each of the following fertilizer materials in corn, winter wheat, and forage production:
 - muriate of potash
 - sulfate of potash magnesia

Competency Area NM-8. Secondary and Micronutrients

45. Describe how soil chemical and physical properties affect magnesium availability, mobility and leaching.
46. Recognize magnesium deficiency symptoms on corn, soybeans, and forages.
47. Describe the agronomic advantages and disadvantages of each of the following magnesium sources:
 - sulfate of potash magnesia
 - magnesium sulfate
 - dolomitic lime.
48. Recognize the deficiency symptoms of:
 - zinc in corn
 - manganese in soybeans and cereals
 - boron in alfalfa
49. Describe how the interaction between the following can affect crop nutrition:

phosphorus and zinc	potassium and magnesium
pH and zinc	weather conditions and boron
pH and manganese	manganese and newly drained fields
50. Describe the components used to calculate the zinc and manganese indexes.
51. Describe advantages and limitations of foliar and soil applied (banded or broadcast) micronutrient applications.
52. Describe the following forms of micronutrients:

Chelates	oxysulfates
oxides	sulfates
53. Describe the risks associated with over application of micronutrient fertilizers.
54. Recognize the contribution of manure or biosolids to secondary and micronutrient supply.

Nutrient Management References

Agronomy Guide for Field Crops. OMAFRA Publication 811, 2009

Soil Fertility Handbook. OMAFRA Pub 611, 2006

Soil Fertility Manual. Potash & Phosphate Institute, 1995.

Soil Management. Best Management Practices Series, AAFC/ OMAFRA, 1994.

Nutrient Management. Best Management Practices Series, AAFC/ OMAFRA, 1994.

Managing Crop Nutrients. Best Management Practices Series, AAFC/ OMAFRA, 2008.

Manure Management. Best Management Practices Series, AAFC/ OMAFRA, 2005.

Nutrient Management Planning. Best Management Practices Series, AAFC/ OMAFRA, 2006.

Ontario Ministry of Agriculture Food and Rural Affairs Website: www.ontario.ca/omafra

Section 2: Soil And Water Quality

Competency Area SWQ-1. Water Cycle and Soil Drainage

1. Describe the hydrologic cycle.
2. Define watershed.
3. Describe the various types of wetlands and their role in the local water cycle.
4. Define the following and how they influence the movement of groundwater:
recharge areas
aquifers
aquitards
5. Describe the pathways by which losses of manure, biosolids, nitrate, phosphorus, and bacteria can impact surface water or groundwater.
6. Describe how crop production practices can impact surface and groundwater.
7. Describe how spacing and depth of tile drains relate to soil texture, internal drainage and topography.
8. Identify the benefits of tile drainage to crop production.
9. Identify the potential impacts of tile drainage on the environment.
10. Describe how the following affect pesticide movement:
method of application precipitation
pesticide adsorption soil erosion
pesticide persistence soil pH
pesticide solubility soil texture

Competency Area SWQ-2. Water Quality

11. Identify the importance of the Federal and Ontario Drinking Water Objectives.
12. Describe how the following water quality problems may be caused by agricultural practices:
excessive algae fish kill
water clarity/turbidity visible contaminants (oil, colour)
13. Distinguish between non-point source and point source pollution.
14. Identify the role of the following in regard to aquatic systems, water quality and water taking:
Environment Canada Ministry of Environment
Fisheries and Oceans Canada Ministry of Natural Resources
Ministry of Agriculture, Food and Rural Affairs

Competency Area SWQ-3. Organic Nutrient Sources (Manures, Sewage Biosolids, and Other Non Agricultural Source Materials)

15. Identify the methods of liquid and solid manure application and list the advantages and disadvantages of each.
16. Identify the advantages and disadvantages of solid vs. liquid manure and biosolids in the context of environmental sustainability and crop production.
17. List advantages and disadvantages of fall versus spring applied organic nutrient sources.
18. Describe agronomic benefits, risks and precautions for land application of organic nutrient sources.
19. Describe the role of organic nutrient sources in nutrient cycling of carbon, nitrogen, phosphorus, and potassium.

20. Describe factors influencing nitrogen release from decomposing organic materials and the microbial processes involved.
21. List the criteria a municipal biosolid must meet to be considered for land application under the Certificate of Approval process.
22. Describe the responsibilities of the farmer, the applicator, the hauler, the generator, and the Ministry of Environment in the land application of non agricultural source materials.
23. Identify regulatory limitations for applying non agricultural source materials to cropland.
24. Identify the various factors that need to be considered when developing a nutrient management plan.

Competency Area SWQ-4. Soil Quality

24. Identify the key indicators of good soil health.
25. Describe how soil organic matter affects soil quality.
26. Define carbon sequestration.
27. Explain the importance of tillage erosion (soil movement by tillage) and its magnitude relative to that of water erosion.
28. Describe the effects of field operations on soil compaction and the resulting impact on crop growth and nutrient requirements.

Competency Area SWQ-5. Soil and Water Conservation Practices

29. Identify the best management practices for the protection of environmentally sensitive areas (i.e. wildlife habitat, riparian zones).
30. Identify best management practices associated with the protection of drinking water sources and water well protection.
31. Describe the benefits of over-winter cover crops for soil quality and nitrogen management.
32. List the benefits of windbreaks.
33. Identify the functions of permanently vegetated buffer strips.
34. Recognize the objectives of the Canada-Ontario Environmental Farm Plan.
35. Identify the potential environmental benefits of Global Positioning Systems (GPS) and Geographic Information Systems (GIS) technology in nutrient management.
36. Identify best management practices to reduce tillage erosion.
37. Identify best management practices to reduce soil compaction.
38. Describe the advantages and disadvantages of maintaining or enhancing wildlife habitat.

Competency Area SWQ-6. Nutrient Management Act and Regulations

39. List the major components of the Ontario Nutrient Management Act & Regulation 267/03 as amended.
40. Describe role of the Nutrient Management Act and Regulations in the management of nutrient applications for the production of crops and the protection of surface and ground water.
41. Explain the difference between agronomic balance and crop removal balance, and where each might be used.
42. Describe how the P index relates to soil test, manure and fertilizer application, and soil erodibility.
43. Describe how the rate and timing of nitrogen applications, crop removal, and soil type relates to the potential for nitrate leaching to groundwater.
44. Describe the following methods for mitigating the impact of runoff to surface water:
 - flow path
 - set back distances

Soil and Water Quality References

Water Management - Best Management Practices Series. AAFC/ OMAFRA 1993.

Fish and Wildlife Habitat Management - Best Management Practices Series. AAFC/ OMAFRA 1996.

Field Crop Production - Best Management Practices Series. AAFC/ OMAFRA 1992

Manure Management - Best Management Practices Series. AAFC/ OMAFRA 2005

No-Till: Making It Work - Best Management Practices Series. AAFC/ OMAFRA 1997

Nutrient Management Planning - Best Management Practices Series. AAFC/ OMAFRA 1998

Water Wells - Best Management Practices Series. AAFC/ OMAFRA 1997

Buffer Strips. Best Management Practices Series. AAFC/ OMAFRA 2004

Managing Crop Nutrients. Best Management Practices Series. AAFC/ OMAFRA 2008

Handbook of Drainage Principles. OMAFRA Publication 73, 1997.

Drainage Guide for Ontario. OMAFRA Publication 29. AAFC/OMAFRA 1998.

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Factsheet:
Maintenance of the Drainage System - Agdex No. 553

Ontario Ministry of Agriculture Food and Rural Affairs Website: www.ontario.ca/omafra

Section 3: Integrated Pest Management

Competency Area IPM-1. Principles and Practices

1. List the steps of an integrated pest management program.
2. Describe the importance of each step of an integrated pest management program.
3. Describe sampling methods for monitoring pest populations.
4. Identify the scouting techniques for the following pests:

potato leafhopper	soybean cyst nematode	wireworm
black cutworm	armyworm	Gibberella stalk rot
two-spotted spider mite	corn rootworm	alfalfa weevil
soybean aphid	fusarium head blight	soybean rust
5. Outline methods for submitting plant and pest material for diagnosis and laboratory analysis.
6. Describe how to use the following variables to calculate the economic injury level (EIL):

cost of control	effectiveness of control action
crop value	pest density/crop damage relationship
7. Describe the unique characteristics of the following: Bt corn, glandular-haired alfalfa, herbicide tolerant crops, SCN resistant soybeans.
8. List advantages and disadvantages of non-chemical pest control.

Competency Area IPM-2. Weed Management

Important weeds in Ontario:

annual sow-thistle	fall panicum	proso millet
barnyard grass	field bindweed	quackgrass
Canada fleabane	field horsetail	Shepard's-purse
Canada thistle	foxtail (green, yellow, and giant)	spreading atriplex
common chickweed	giant ragweed	velvetleaf
common milkweed	lady's-thumb	waterhemp (common)
common ragweed	lamb's-quarters	wild carrot
crab grass (smooth & large)	perennial sow-thistle	wire-stemmed muhly
Eastern black nightshade	pigweed (redroot and green)	yellow nut sedge

9. Identify all important weeds in Ontario by common name at the 3 to 6 leaf growth stage.
10. Classify all important weeds in Ontario by life cycle (annual, biennial or perennial).
11. Describe growth habit of all important weeds in Ontario.
12. Describe the life cycles of:

summer annuals	biennials
winter annuals	perennials
13. Describe the following vegetative reproductive structures: rhizomes, tubers, bulbs.
14. Identify weeds that exhibit the following structures: rhizomes, tubers, bulbs.
15. Describe how different tillage systems (conventional, conservation and no-till) influence the type and populations of weeds.

16. Compare and contrast weed control strategies for winter annual, summer annual, biennial, and perennial weeds.

17. Describe crop injury symptoms of these herbicides on corn, soybeans, alfalfa and cereals:

2,4-D	fomesafen	nicosulfuron/rimsulfuron
atrazine	glyphosate	pendimethalin
bentazon	isoxaflutole	surfactants
bromoxynil	mesotrione	thifensulfuron
dicamba	metolachlor	
flumioxazin	metribuzin	

18. Describe how the following may affect herbicide retention and absorption in plant leaves:

additives	rain-free time	type of carrier
leaf orientation	spray volume	weed size
plant canopy		

19. Describe how the following factors affect cuticular penetration:

herbicide solubility in water	relative humidity
moisture	temperature

20. Distinguish between contact and systemic herbicides.

21. Define weed competition and describe factors that influence competition.

22. Describe the concept of the critical weed-free period.

23. Recognize how soil organic matter, soil texture, soil pH, soil moisture, and soil temperature impact degradation and efficacy of herbicides.

24. Describe how manure can influence the effectiveness of soil applied herbicides.

25. Describe how herbicide chemical properties, environmental conditions, and application method influence volatilization.

Competency Area IPM-3. Disease and Nematode Management

26. For each of the following field crop diseases:

- describe symptoms and plant parts affected
- identify conditions that favour pathogen development
- identify appropriate management responses
- identify the category of the pathogen (viruses, bacteria, fungi, nematodes)

Corn	Soybeans	Winter Wheat
Anthracnose leaf blight	Brown stem rot	Bunt (dwarf, common)
Common smut	Damping off	Fusarium head blight
Common rust	Downy mildew	Leaf rust
Ear moulds (Diplodia, Fusarium, Gibberella)	Fusarium root rot	Loose smut
Eye Spot	Phomopsis seed mould	Mosaic virus
Grey leaf spot	Phytophthora root rot	Powdery mildew
Northern leaf blight	Powdery mildew	Septoria leaf blotch
Stalk rots (Anthracnose, Fusarium, Diplodia, Gibberella)	Rhizoctonia	Stagonospora glume blotch
Stewart's wilt	Soybean cyst (SCN)	Stem rust
	Soybean mosaic virus	Stripe rust
	Stem canker	Yellow dwarf
	Sudden death syndrome	

Alfalfa

Aphanomyces root rot
Brown root rot
Common leaf spot
Phytophthora root rot
Verticillium wilt

27. Describe the importance of crop residue management on the following diseases: corn stalk rots Northern leaf blight in corn, brown stem rot in soybeans, Fusarium head blight in winter wheat and sudden death syndrome in soybeans.
28. Distinguish between race specific resistance and partial resistance (tolerance) for phytophthora root rot in soybeans.
29. Define mycotoxin, list the mycotoxins commonly found in Ontario grain and silage, and describe how they are detected.
30. Recognize the impact of mycotoxins on crop quality and describe strategies for minimizing contamination of commodities by mycotoxins.

Competency Area IPM-4. Insect, Mite and Slug Management

Important Insects, Mites and Slugs of Ontario:

alfalfa blotch leafminer	European chafer grub	seedcorn maggot
alfalfa snout beetle	European corn borer	soybean aphid
alfalfa weevil	fall armyworm	slugs
bean leaf beetle	corn flea beetle	swede midge
cabbage seedpod weevil	June beetle grub	true armyworm
cereal leaf beetle	Mexican bean beetle	two-spotted spider mite
corn rootworm	potato leafhopper	western bean cutworm
black cutworm		wireworm

33. Identify the pest and the crop injury symptoms for important insects, mites and slugs of Ontario.
34. Identify appropriate management responses to important insects, mites and slugs of Ontario.
35. Describe how temperature, photoperiod, competition, and moisture influence insect populations.
36. Identify beneficial organisms (predators, parasitoids and pathogens) for the following insect pests:

alfalfa weevil	soybean aphid
cereal leaf beetle	true armyworm

37. List advantages and limitations for chemical control of the following insect pests:

corn rootworm	potato leaf hopper
European corn borer	soybean aphid

38. List advantages and limitations of the following cultural controls for insect, mite and slug crop pests:

harvest date	resistant cultivars	sanitation
planting date	rotation	tillage

Competency Area IPM-5. Pesticide Resistance Management

39. Define pesticide resistance and cross resistance.

40. Describe how a pest develops resistance to pesticides.
41. Identify the following plant or pest population responses:
 - resistance
 - susceptibility
 - tolerance
42. Describe how to minimize pesticide resistance development.
43. Describe how refugia are used to minimize the risk of resistance development of European corn borer and corn rootworm to Bt.
44. Identify Ontario weed species with resistance to herbicides.

Competency Area IPM-6. Pesticide Stewardship & the Environment

45. Describe best management practices for pesticide mixing, loading, application, transportation, disposal and storage.
46. Describe the proper procedures for cleaning a field sprayer.
47. Recognize government regulations for safe handling, storage, application, transportation and disposal of pesticides.
48. Describe components of a pesticide label.
49. Describe how to minimize adverse effects on non-target organisms when using pesticides.
50. Distinguish between spray drift and volatilization.
51. Describe the advantages, limitations and uses of the following spray nozzle types:

Air Induction (A.I.)	Flood Jet
Flat Fan	Hollow Cone
52. Describe how the following factors affect spray delivery, coverage and drift:

boom height	nozzle type	spray viscosity
droplet size	orifice size	spray volume
ground speed	spray pressure	wind speed
nozzle spacing		

Integrated Pest Management References

Guide to Weed Control. OMAFRA Publication 75.
 Ontario Weeds. OMAFRA Publication 505.
 Diseases of Field Crops in Canada. K. L. Bailey, B. D. Gossen, R. K. Gugel & R. A. A. Morrall, 2003. Canadian Phytopathological Society.
 Agronomy Guide for Field Crops. OMAFRA Publication 811, 2009.
 Field Crop Protection Guide. OMAFRA Publication 812.
 Identification Guide to the Weeds of Quebec. ISBN 2-89457-174-7. MAPAQ
 Integrated Pest Management. Best Management Practices Series, AAFC/ OMAFRA, 1996.
 Pesticide Storage, Handling and Application. Best Management Practices Series, AAFC/ OMAFRA, 1998.
 Growers' Pesticide Safety Course Training Manual (available from Ontario Pesticide Education Program, Ridgetown Campus/University of Guelph).
 Ontario Ministry of Agriculture Food and Rural Affairs Website: www.ontario.ca/crops
 Entomology and Pest Management Larry P. Pedigo & Marlin E. Rice. 6th Edition, Prentice-Hall, Inc. 2009
 CropPest Ontario. www.omafra.gov.on.ca/croppest

A Grower's Handbook – Controlling Corn Insect Pests with Bt Technology. 2nd Edition, Canadian Corn Pest Coalition. 2004. www.cornpest.com
Weed Info, www.weedinfo.ca
A Field Guide to Broadleaf Weeds, <http://www.cerealcentral.ca/English/Resource/2/File.ashx>
A Field Guide to Grassy Weeds, <http://www.cerealcentral.ca/English/Resource/3/File.ashx>

Section 4: Crop Management

Competency Area CM-1. Crop Adaptation

1. Describe corn and soybean responses to frost in late spring or early fall, severe enough to kill the above ground portion of the plants.
2. Describe how Ontario Crop Heat Units differ from Growing Degree Days (GDD).
3. Use the Ontario Crop Heat Unit map to select areas in which corn, soybean and dry bean varieties are adapted.
4. Select spring cereal varieties for a given location using the test area descriptions.
5. Describe relative maturity (days to maturity) for corn, soybeans and edible beans.
6. Use the critical fall harvest period map in OMAFRA Publication 811 to determine harvest management for alfalfa.
7. Describe soil and climatic factors responsible for successful winter survival of alfalfa, perennial forage grasses, winter canola and winter wheat.
8. Describe relative growing characteristics of perennial forage grass species:
 - jointing versus non-jointing
 - bunching versus spreading
 - seedling vigour
 - maturity
 - yield and regrowth
 - tolerance to close grazing
 - sensitivity to poor drainage, drought, and low soil pH

Competency Area CM-2. Seed Quality

9. List advantages of pedigreed seed.
10. Describe the importance of the Canadian Seed Standards.
11. List factors used to select hybrids or varieties of corn, soybeans, wheat, barley, canola, alfalfa, and forage grasses.
12. Describe differences between seed germination and seed vigour for soybeans.

Competency Area CM-3. Crop Growth And Development Staging

13. Describe the major growth scales (for example, Zadok's) used to identify crop development stages of corn, soybeans, and cereals.
14. Describe the growth phases when corn, soybeans and spring canola are most affected by heat and/or drought stress.
15. Describe the growth phases when corn, soybeans, cereals and edible beans are most affected by herbicide and disease stress.

Competency Area CM-4. Tillage Systems

16. Describe how the following affect the feasibility of conservation tillage systems:
- | | |
|------------------------|--------------------------|
| soil type and texture | crop species and variety |
| heat unit availability | cropping sequence |
17. Describe how soil fertility management changes when adopting conservation tillage systems.
18. Describe how pest management changes when adopting conservation tillage systems.
19. List soil textures suited to fall and spring primary tillage.
20. Describe advantages and disadvantages of fall and spring primary tillage.
21. Describe advantages and disadvantages of rotary hoeing and inter-row cultivation after planting.

Competency Area CM-5. Seeding Factors

22. List typical seeding rates, depths and row spacings for corn, soybeans, edible beans, cereals and forages.
23. Describe the effect of plant population and row spacing on sunlight interception, weed competition, diseases, lodging and yield.
24. Describe the purpose, advantages and disadvantages of seed treatments.
25. Describe appropriate inoculant materials and inoculant handling methods for soybeans and forage legumes.
26. Explain the criteria used when assessing whether to replant corn, soybeans, edible beans or winter wheat.
27. Explain the factors that would affect seeding depth selection for corn, soybeans, winter wheat, forage grasses, forage legumes, spring cereals.
28. Discuss the factors to consider when deciding to drill or broadcast seed for forage grasses and legumes.
29. Describe how to adjust seeding rate and maturity if environmental conditions cause a planting delay or a replant.
30. List recommended seeding dates for corn, soybeans, winter wheat, barley, oats, alfalfa, and edible beans.
31. Describe the relationship between seeding date and yield potential for corn, corn silage, soybeans, winter wheat, and barley.
32. Describe impact of seed treatments on inoculants.

Competency Area CM-6. Crop Utilization and Harvesting Quality

33. List optimum development stages to harvest corn, corn silage, soybeans, winter wheat and barley.
34. List development stages for harvesting alfalfa and grass forages at optimum forage quality (crude protein, acid detergent fibre, neutral detergent fibre, and neutral detergent fibre digestibility) and at optimum dry matter yield.
35. Describe the unique characteristics and end uses of the following crop types:
- a) Corn: waxy, high oil, low phytate, white, highly digestible starch, silage quality (high digestibility)
 - b) Soybean: yellow hilum, high protein, natto, non-genetically modified (GM)

c) Wheat: hard, soft, red, white

- 36. Describe the key components in an Identity Preserved Crop program.
- 37. Describe the strategies to minimize the risks of GM contamination.

Competency Area CM-7. Cropping Systems

- 38. Describe the advantages and disadvantages of a monoculture versus a crop rotation system.
- 39. Describe the advantages and disadvantages of organic cropping systems.
- 40. Describe the advantages and disadvantages of direct seeding forages compared to seeding with a companion crop.
- 41. Describe grazing systems that optimize livestock production on pastures.
- 42. List advantages and limitations of the following cultural practices with respect to control of weeds, pests and diseases:

crop rotation	planting date	use of tramlines
cover crops	soil fertility	variety selection
nurse crops	tillage	
- 43. Describe the potential problems with poor residue management.

Competency Area CM-8. Safe Storage And Quality

- 44. List the safe moisture levels to store corn silage, haylage, wrapped bales, and cereal silage.
- 45. List the conditions necessary for grains to retain optimum quality in storage.
- 46. Describe the factors involved in evaluating grade quality of corn, soybeans, edible beans, canola, and cereals.
- 47. Describe the causes and the effects of silo gases.

Competency Area CM-9. Economics

- 48. Define maximum economic yield in terms of the law of diminishing returns.
- 49. Use Crop Budgets to estimate costs and evaluate cropping alternatives.
- 50. Recognize key components of the Ontario Agricorp Production Insurance program.

Competency Area CM-10. Regulatory

- 51. Recognize stipulations of the Canadian Seeds Act that pertain to crop production.
- 52. Recognize key components of Plant Breeders' Rights.
- 53. Understand the role of the Canadian Food Inspection Agency relating to non-GM crops and the steps involved in registering novelty trait crops.
- 54. Discuss the consequences of recommending and using non-registered products.
- 55. Recognize requirements of the Canadian Organic Products Regulations and the related standards for the production and marketing of organic crops and related products.

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