Two Professional Development Certificate Programs in Applied Horticulture

Prepared by Jason Vodden, Myron Smith and Jeff Dawson

Department of Biology, Carleton University

July 6, 2026

Revised November 5, 2026

Professional Development Certificate Programs in Applied Horticulture

Table of Contents

A) Overview of Professional Development Certificate Programs in Applied Horticulture 4

B) Schedule for Professional Development Program in Applied Horticulture and Plant Production 5

B.1) Winter Session (February–April, 10 weeks) 5

B.2) Weekly Timetable 5

B.3) Weekly Contact Hours 5

C) Schedule for Professional Development Certificate Program in Applied Horticulture: Food Sustainability with Environmental Stewardship 6

C.1) Summer Session (May–July 10 weeks) 6

C.2) Weekly Timetable 6

C.3) Weekly Contact Hours 6

D) Module details for Professional Development Certificate Program in Applied Horticulture and Plant Production 7

D.1) Module name: Plant Science 7

D.1-1) Module Format 7

D.1-2) Module Description 7

D.1-3) Detailed weekly topics with learning outcomes & laboratory activities 7

D.1-4) Student Assessment 13

D.1-5) Module Outcomes 13

D.2) Module name: Plant Propagation 14

D.2-1) Module Format 14

D.2-2) Module Description 14

D.2-3) Detailed weekly topics with learning outcomes & laboratory activities 14

D.2-4) Assessment Strategy 20

D.2-5) Module Outcomes 20

D.3) Module name: Greenhouse Operations & Nursery Production 21

D.3-1) Module Format 21

D.3-2) Module Description 21

D.3-3) Detailed weekly topics with learning outcomes & laboratory activities 21

D.3-4) Assessment Strategy 27

D.3-5) Module Outcomes 27

E) Module Details for Professional Development Program in Applied Horticulture: Food Sustainability with Environmental Stewardship 28

E.1) Module name: Sustainable Food Production 28

E.1-1) Module Format 28

E.1-2) Module Description 28
E.1-3) Detailed weekly topics with learning outcomes & laboratory activities 29
E.1-4) Assessment Strategy 34
E.1-5) Module Outcomes 35
E.2) Module name: Sustainable Environmental Principles in Horticulture 35
E.2-1) Module Format 35
E.2-2) Module Description 35
E.2-3) Detailed weekly topics with learning outcomes & laboratory activities 36
E.2.4) Assessment Strategy 42
E.2-5) Module Outcomes 42
E.3) Module name: Invasive Plant Management 43
E.3-1) Module Format 43
E.3-2) Module Description 43
E.3-3) Detailed weekly topics with learning outcomes & laboratory activities 43
E.3-4) Assessment Strategy 49
E.3-5) Module Outcomes 50

A) Overview of Professional Development Certificate Programs in Applied Horticulture

We offer two Professional Development Certificate programs in Applied Horticulture within the Faculty of Science at Carleton University:

1) **HORT 1000: Applied Horticulture and Plant Production**
2) **HORT 1001: Applied Horticulture: Food Sustainability with Environmental Stewardship**

Each program is designed to provide students with theoretical knowledge and practical skills in enriching and marketable areas of plant husbandry. These Professional Development Certificate programs are built to welcome applicants from all walks of life, including high school graduates, professionals, university students and retirees. An important goal is to facilitate transfer of cultural and life experiences among the students. To provide maximum flexibility, each program can be taken separately in either order. The timing of each program coincides with seasonal cycles. Applied Horticulture and Plant Production will take place in our greenhouse facilities from February to April (10 weeks), a time of anticipation and planning for the summer season, and will include business considerations of bedding plant production. The Applied Horticulture: Food Sustainability with Environmental Stewardship program will make use of the Carleton Biology Teaching and Research (T&R) Garden and will run from May to July (10 weeks).

As outlined below, each 120-hour program runs for 10 weeks. Students take 3 modules over 3 days per week. Each module consists of a 1-hour lecture followed by a 3-hour lab that emphasizes experiential learning. The curriculum for each program is structured to ensure that each laboratory session directly reinforces the learning objectives presented during the lecture. Through practical activities, students will apply concepts introduced in class, develop technical horticultural skills, and gain real-world experience in plant production and food systems. This integrated approach promotes deeper understanding, skill development, and industry readiness by bridging the gap between theory and practice.

B) Schedule for Professional Development Program in Applied Horticulture and Plant Production

B.1) Winter Session (February–April, 10 weeks)

Focus: Indoor Plant Production

Comprising 3 modules: 1) Plant Science, **2)** Plant Propagation, and **3)** Greenhouse Operations & Nursery Production

B.2) Weekly Timetable

Monday	**Time**
Plant Science Lecture	9:00–10:00 AM
Break	10:00–10:15 AM
Plant Science Lab	10:15 AM–1:15 PM

Tuesday	**Time**
Plant Propagation Lecture	9:00–10:00 AM
Break	10:00–10:15 AM
Plant Propagation Lab	10:15 AM–1:15 PM

Wednesday	**Time**
Greenhouse Operations & Nursery Production Lecture	9:00–10:00 AM
Break	10:00–10:15 AM
Greenhouse Operations & Nursery Production Lab	10:15 AM–1:15 PM

B.3) Weekly Contact Hours

Module	**Lecture**	**Lab**	**Total**
Plant Science	1 hour	3 hours	4 hours
Plant Propagation	1 hour	3 hours	4 hours
Greenhouse Operations & Nursery Production	1 hour	3 hours	4 hours
Total	**3 hours**	**9 hours**	**12 ours/week**

C) Schedule for Professional Development Certificate Program in Applied Horticulture: Food Sustainability with Environmental Stewardship

C.1) Summer Session (May–July 10 weeks)

Focus: Outdoor Horticulture, Food Production and Ecological Stewardship

Comprising 3 modules: 1) Sustainable Food Production, **2)** Environmental principles in horticulture, and **3)** Invasive Plant Management

C.2) Weekly Timetable

Monday	**Time**
Sustainable Food Production Lecture	9:00–10:00 AM
Break	10:00–10:15 AM
Sustainable Food Production Lab	10:15 AM–1:15 PM

Tuesday	**Time**
Environmental principles in horticulture	9:00–10:00 AM
Break	10:00–10:15 AM
Ecological Restoration & Native Plant Systems Lab	10:15 AM–1:15 PM

Wednesday	**Time**
Invasive Plant Management Lecture	9:00–10:00 AM
Break	10:00–10:15 AM
Invasive Plant Management Lab	10:15 AM–1:15 PM

C.3) Weekly Contact Hours

Module	**Lecture**	**Lab**	**Total**
Sustainable Food Production	1 hour	3 hours	4 hours
Environmental principles in horticulture	1 hour	3 hours	4 hours
Invasive Plant Management	1 hour	3 hours	4 hours
Total	**3 hours**	**9 hours**	**12 hours/week**

D) Module details for Professional Development Certificate Program in Applied Horticulture and Plant Production

D.1) Module name: Plant Science

D.1-1) Module Format

- **Duration:** 10 Weeks
- **Schedule:** 1 day per week
- **Class Length:** 4 hours per class
    - 1 hour lecture
    - 3 hours laboratory/hands-on learning
- **Instructional Approach:** Laboratory activities are directly aligned with lecture content to reinforce key concepts through experiential learning.

D.1-2) Module Description

This module provides students with a foundational understanding of plant science as it relates to horticulture and plant production. Students will explore plant anatomy, physiology, growth, reproduction, environmental responses, nutrition, and propagation through a combination of classroom instruction and hands-on laboratory experiences. Emphasis is placed on applying scientific principles to practical horticultural production systems.

D.1-3) Detailed weekly topics with learning outcomes & laboratory activities

Week 1: Introduction to Plant Science

Lecture Topics

- Importance of plant science in horticulture
- Major plant groups
- Plant life cycles
- Scientific plant nomenclature

Learning Outcomes

Students will:

- Explain the role of plant science in horticulture.
- Identify major plant groups.
- Describe plant life cycles and growth habits.

Laboratory Activities

- Greenhouse and laboratory orientation
- Plant identification exercise
- Plant classification scavenger hunt
- Collection and labeling of plant specimens

Week 2: Plant Anatomy and Morphology

Lecture Topics

- Root systems
- Stems and vascular tissues
- Leaves and their functions
- Flowers, fruits, and seeds

Learning Outcomes

Students will:

- Identify major plant structures.
- Explain the function of plant organs.
- Distinguish between monocots and dicots.

Laboratory Activities

- Plant dissections
- Root and stem cross-sections
- Leaf morphology identification
- Flower dissection and labeling

Week 3: Plant Cells and Tissues

Lecture Topics

- Plant cell structure
- Specialized cells and tissues
- Cell division and growth

Learning Outcomes

Students will:

- Identify plant cell components.
- Describe tissue functions.
- Explain the role of cell division in plant growth.

Laboratory Activities

- Microscope training
- Examination of plant cells
- Tissue identification slides
- Cell structure sketching and documentation

Week 4: Photosynthesis and Respiration

Lecture Topics

- Photosynthesis process
- Plant respiration
- Energy production and utilization

Learning Outcomes

Students will:

- Explain photosynthesis and respiration.
- Describe factors affecting plant productivity.

Laboratory Activities

- Photosynthesis experiments
- Light intensity measurements
- Starch testing in leaves
- Environmental factor comparisons

Week 5: Plant Growth and Development

Lecture Topics

- Plant hormones
- Tropisms
- Growth stages

Learning Outcomes

Students will:

- Describe hormone functions.
- Explain environmental influences on growth.
- Identify growth stages in production crops.

Laboratory Activities

- Hormone demonstration experiments
- Phototropism and gravitropism trials
- Growth measurement exercises
- Plant development observations

Week 6: Soil Science Fundamentals

Lecture Topics

- Soil composition
- Soil structure and texture
- Soil-water relationships

Learning Outcomes

Students will:

- Identify soil components.
- Evaluate soil properties.
- Understand soil's role in plant production.

Laboratory Activities

- Soil texture analysis
- Soil profile examination
- Bulk density determination
- Water infiltration testing

Week 7: Plant Nutrition and Fertility

Lecture Topics

- Essential plant nutrients
- Nutrient deficiencies
- Fertilizer types and application

Learning Outcomes

Students will:

- Recognize nutrient deficiency symptoms.
- Explain nutrient functions.
- Calculate basic fertilizer requirements.

Laboratory Activities

- Deficiency symptom identification
- Fertilizer label interpretation
- Soil and nutrient testing
- Fertilizer application exercises

Week 8: Environmental Factors Affecting Plant Growth

Lecture Topics

- Water uptake and transport
- Transpiration
- Light, temperature, and humidity
- Growing environments
- Climate considerations

Learning Outcomes

Students will:

- Explain water movement through plants.
- Evaluate irrigation methods.
- Assess plant water requirements.
- Assess environmental impacts on crops.
- Monitor growing conditions.
- Adjust environmental controls.

Laboratory Activities

- Soil moisture monitoring
- Transpiration experiments
- Water-use efficiency assessment
- Greenhouse environmental monitoring
- Light and temperature measurements
- Environmental control system operation
- Plant stress evaluations

Week 9: Plant Reproduction

Lecture Topics

- Sexual reproduction
- Pollination and fertilization
- Seed development

Learning Outcomes

Students will:

- Explain plant reproductive processes.
- Identify reproductive structures.
- Describe seed formation.

Laboratory Activities

- Flower dissections
- Pollination demonstrations
- Seed collection and evaluation
- Germination testing

Week 10: Plant Identification, Growth Habits, Plant Health and Integrated Review

Lecture Topics

- Principles of plant identification
- Common horticultural plant groups
- Annuals, biennials, and perennials
- Trees, shrubs, vines, and herbaceous plants
- Plant growth forms and habits
- Plant stress
- Disease, pest, and disorder identification

- Review of key plant science concepts

Learning Outcomes

Students will:

- Identify common horticultural plant types.
- Distinguish between annual, biennial, and perennial life cycles.
- Classify plants based on growth habit.
- Use basic botanical terminology for plant identification.
- Diagnose common plant health issues.
- Apply plant science principles to production scenarios.
- Demonstrate foundational plant science competency

Laboratory Activities

- Plant identification walk through greenhouse and landscape areas
- Use of plant identification keys and reference materials
- Examination of plant growth habits and structures
- Creation of a plant identification collection or portfolio
- Labeling and classification exercises
- Plant diagnostic workshop
- Production problem-solving exercises
- Comprehensive plant identification assessment
- Final practical skills evaluation

D.1-4) Student Assessment

Assessment	Weight
Laboratory Participation and Skills	30%
Weekly Quizzes	15%
Laboratory Reports	20%
Plant Identification Assignment	10%
Midterm Practical Assessment	10%
Final Practical Examination	15%

D.1-5) Module Outcomes

Upon successful completion of this module, students will be able to:

1. Describe plant structure, growth, and development.

2. Apply plant science principles in horticultural production systems.
3. Identify plant species and plant health issues.
4. Utilize appropriate propagation techniques.
5. Assess soil, nutrition, and environmental factors affecting plant growth.
6. Demonstrate practical skills required for greenhouse, nursery, and plant production operations.
7. Integrate scientific knowledge with horticultural best management practices.

D.2) Module name: Plant Propagation

D.2-1) Module Format

- **Duration:** 10 Weeks
- **Schedule:** 1 Day per Week
- **Class Structure:** 1 Hour Lecture, 3 Hours Laboratory
- **Delivery Model:** Hands-on, experiential learning aligned with weekly lecture objectives

---

D.2-2) Module Description

This module provides students with the knowledge and practical skills required to propagate horticultural crops using both sexual and asexual propagation methods. Students will examine the biological principles underlying plant propagation while developing hands-on competencies in seed propagation, cuttings, division, grafting, budding, and nursery production techniques. Laboratory activities emphasize industry-standard practices, plant handling, sanitation, environmental management, and the evaluation of propagation success.

D.2-3) Detailed weekly topics with learning outcomes & laboratory activities

Week 1: Introduction to Plant Propagation

Lecture Topics

- Importance of plant propagation in horticulture
- Sexual vs. asexual propagation
- Propagation facilities and equipment
- Health and safety practices

Learning Outcomes

Students will:

- Describe the purpose and importance of plant propagation.
- Differentiate between sexual and asexual propagation.
- Identify common propagation tools and facilities.

Laboratory Activities

- Greenhouse and propagation facility orientation
- Tool identification and safe use
- Sanitation procedures
- Preparation of propagation benches and growing media

Week 2: Propagation Media and Environmental Conditions

Lecture Topics

- Characteristics of propagation media
- Water-holding capacity and aeration
- Temperature, humidity, and light requirements
- Environmental controls

Learning Outcomes

Students will:

- Evaluate propagation media characteristics.
- Explain environmental factors affecting propagation success.
- Select appropriate media for specific crops.

Laboratory Activities

- Mixing propagation media
- Media comparison trials
- Monitoring temperature and humidity
- Setting up propagation trays and containers

Week 3: Seed Structure and Germination

Lecture Topics

- Seed anatomy
- Germination requirements

- Seed viability and vigor
- Factors affecting germination

Learning Outcomes

Students will:

- Identify seed structures and functions.
- Explain the germination process.
- Assess factors influencing seed quality.

Laboratory Activities

- Seed dissection
- Germination testing
- Germination chamber setup
- Recording germination rates

Week 4: Seed Propagation Techniques

Lecture Topics

- Direct seeding
- Transplant production
- Plug and tray systems
- Seedling management

Learning Outcomes

Students will:

- Demonstrate proper seeding techniques.
- Manage seedlings through early growth stages.
- Evaluate seedling quality.

Laboratory Activities

- Seed sowing of various crop species
- Transplant tray preparation
- Seedling emergence monitoring
- Thinning and transplanting exercises

Week 5: Dormancy and Seed Treatments

Lecture Topics

- Types of seed dormancy
- Stratification
- Scarification
- Seed storage practices

Learning Outcomes

Students will:

- Explain causes of seed dormancy.
- Apply appropriate dormancy-breaking treatments.
- Store seeds according to industry standards.

Laboratory Activities

- Mechanical scarification exercises
- Cold stratification treatments
- Seed viability testing
- Seed storage evaluation

Week 6: Introduction to Vegetative Propagation

Lecture Topics

- Advantages and disadvantages of vegetative propagation
- Plant parts used for propagation
- Clone production
- Stock plant selection

Learning Outcomes

Students will:

- Describe common vegetative propagation methods.
- Identify suitable plant materials for propagation.
- Explain the concept of cloning in horticulture.

Laboratory Activities

- Identification of plant structures used in propagation
- Stock plant evaluation
- Collection and preparation of propagation material
- Sanitation and handling practices

Week 7: Stem Cuttings

Lecture Topics

- Types of stem cuttings
- Root initiation and development
- Rooting hormones
- Environmental requirements

Learning Outcomes

Students will:

- Differentiate among cutting types.
- Prepare cuttings for rooting.
- Evaluate rooting success.

Laboratory Activities

- Softwood, semi-hardwood, and hardwood cuttings
- Hormone application
- Mist bench operation
- Root development monitoring

Week 8: Division, Separation, and Layering

Lecture Topics

- Division methods
- Separation of bulbs, corms, and rhizomes
- Layering techniques

Learning Outcomes

Students will:

- Apply various vegetative propagation techniques.
- Determine appropriate methods for different plant species.
- Evaluate successful establishment.

Laboratory Activities

- Dividing perennials

- Propagation from bulbs and rhizomes
- Simple and air-layering exercises
- Plant establishment assessment

Week 9: Grafting and Budding

Lecture Topics

- Principles of grafting
- Graft compatibility
- Budding techniques
- Applications in horticulture

Learning Outcomes

Students will:

- Explain the purpose of grafting and budding.
- Identify compatible scion and rootstock combinations.
- Perform basic grafting procedures.

Laboratory Activities

- Tool preparation and sanitation
- Whip-and-tongue grafting
- Cleft grafting demonstrations
- Budding practice exercises

Week 10: Modern Techniques, Propagation Troubleshooting, Nursery Production and Module Review

Lecture Topics

- Introduction to tissue culture and commercial applications
- Emerging propagation technologies
- Monitoring propagation success
- Common propagation problems
- Transitioning propagated plants to production
- Hardening-off procedures
- Quality standards and Record keeping
- Review of propagation principles

Learning Outcomes

Students will:

- Describe the principles and use of micropropagation.
- Recognize modern propagation technologies.
- Diagnose common propagation issues and implement corrective actions.
- Maintain accurate production records.
- Prepare propagated plants for production environments.
- Assess plant quality and readiness for sale or transplanting.
- Demonstrate comprehensive propagation knowledge and skills.

Laboratory Activities

- Tissue culture facility tour or demonstration
- Sterile technique exercises
- Media preparation demonstration
- Troubleshooting propagation failures
- Disease and pest identification
- Propagation record analysis
- Potting-up rooted plants
- Hardening-off procedures
- Plant quality assessment
- Final practical skills evaluation

D.2-4) Assessment Strategy

Assessment	Weight
Laboratory Participation and Skills	30%
Weekly Quizzes	10%
Propagation Logs and Records	15%
Midterm Practical Assessment	15%
Propagation Project	15%
Final Practical Examination	15%

D.2-5) Module Outcomes

Upon successful completion of this module, students will be able to:

1. Explain the scientific principles of plant propagation.
2. Propagate plants using seeds, cuttings, division, layering, grafting, and budding techniques.
3. Select appropriate propagation methods for a variety of horticultural crops.
4. Manage environmental conditions for successful propagation.

5. Diagnose and correct common propagation problems.
6. Maintain safe and sanitary propagation facilities.
7. Demonstrate industry-standard propagation skills applicable to greenhouse, nursery, and plant production operations.

D.3) Module name: Greenhouse Operations & Nursery Production

D.3-1) Module Format

- **Duration:** 10 Weeks
- **Schedule:** 1 Day per Week
- **Class Structure:** 1 Hour Lecture, 3 Hours Laboratory
- **Delivery Method:** Lecture-supported experiential learning
- **Focus:** Greenhouse crop production, nursery management, environmental control, crop care, and facility operations

---

D.3-2) Module Description

This module provides students with the fundamental knowledge and practical skills required to operate greenhouse and nursery production facilities. Students will develop competencies in greenhouse systems, crop production, environmental management, irrigation, fertility, pest management, and nursery operations. Through hands-on laboratory activities, students will apply industry-standard production techniques while gaining experience in facility management and crop maintenance.

D.3-3) Detailed weekly topics with learning outcomes & laboratory activities

Week 1: Introduction to Greenhouse and Nursery Production

Lecture Topics

- Overview of greenhouse and nursery industries
- Types of production facilities
- Greenhouse structures and nursery layouts
- Workplace safety and sanitation

Learning Outcomes

Students will:

- Describe the role of greenhouse and nursery production within the horticulture industry.
- Identify common production structures and systems.
- Demonstrate safe work practices.

Laboratory Activities

- Facility orientation
- Identification of greenhouse components
- Equipment and tool safety training
- Sanitation procedures and protocols
- Facility inspection exercise

Week 2: Greenhouse Structures and Environmental Systems

Lecture Topics

- Greenhouse design and construction
- Heating systems
- Ventilation systems
- Environmental monitoring equipment

Learning Outcomes

Students will:

- Identify major greenhouse environmental control systems.
- Explain how environmental systems affect crop growth.
- Monitor production environments.

Laboratory Activities

- Environmental control system tour
- Monitoring temperature and humidity
- Ventilation system inspection
- Greenhouse maintenance exercises

Week 3: Growing Media and Container Production

Lecture Topics

- Types of growing media
- Media properties
- Container selection
- Potting and transplanting principles

Learning Outcomes

Students will:

- Evaluate different growing media.
- Select appropriate containers for crop production.
- Prepare media for planting.

Laboratory Activities

- Growing media comparisons
- Media mixing exercises
- Container filling techniques
- Potting and transplanting activities

Week 4: Seeding and Crop Establishment

Lecture Topics

- Seedling production
- Direct seeding and plug production
- Germination requirements
- Crop establishment techniques

Learning Outcomes

Students will:

- Apply proper seeding procedures.
- Monitor crop establishment.
- Evaluate seedling quality.

Laboratory Activities

- Seed sowing
- Plug tray preparation
- Germination monitoring
- Seedling evaluation and record keeping

Week 5: Irrigation Systems and Water Management

Lecture Topics

- Plant water requirements
- Irrigation methods
- Water quality considerations
- Efficient water management

Learning Outcomes

Students will:

- Explain irrigation principles.
- Operate common irrigation systems.
- Monitor plant water needs.

Laboratory Activities

- Hand watering techniques
- Drip irrigation system setup
- Overhead irrigation evaluation
- Soil moisture assessments

Week 6: Fertility Management and Plant Nutrition

Lecture Topics

- Essential plant nutrients
- Fertilizer types
- Fertigation systems
- Nutrient deficiency symptoms

Learning Outcomes

Students will:

- Identify plant nutrient requirements.
- Apply fertilizers safely and effectively.
- Diagnose common nutrient deficiencies.

Laboratory Activities

- Fertilizer mixing and calculations
- EC and pH testing
- Nutrient deficiency identification
- Fertigation system demonstrations

Week 7: Plant Growth and Crop Maintenance

Lecture Topics

- Factors affecting plant growth
- Pruning and pinching
- Plant spacing
- Crop quality management

Learning Outcomes

Students will:

- Apply crop maintenance techniques.
- Monitor plant growth and development.
- Improve plant quality through cultural practices.

Laboratory Activities

- Plant spacing exercises
- Pruning and pinching activities
- Growth measurements
- Crop quality evaluations

Week 8: Integrated Pest Management (IPM)

Lecture Topics

- Common greenhouse and nursery pests
- Disease identification
- IPM principles
- Biological, cultural, and chemical controls

Learning Outcomes

Students will:

- Identify common pests and diseases.
- Apply IPM strategies.
- Monitor plant health effectively.

Laboratory Activities

- Pest scouting exercises
- Disease diagnosis activities

- Beneficial insect identification
- Monitoring and record-keeping exercises

Week 9: Greenhouse and Nursery Production Practices and Equipment Operation

Lecture Topics

- Greenhouse and Nursery production systems
- Field-grown versus container-grown crops
- Tree and shrub production
- Nursery maintenance practices
- Production equipment and tools
- Maintenance procedures
- Equipment safety
- Mechanization in horticulture

Learning Outcomes

Students will:

- Differentiate between nursery production methods.
- Explain the production cycle of nursery crops.
- Perform common nursery maintenance tasks.
- Identify common greenhouse and nursery equipment.
- Perform routine maintenance tasks.
- Demonstrate safe equipment operation.

Laboratory Activities

- Nursery crop identification
- Containerized plant production
- Root inspection exercises
- Nursery maintenance activities
- Equipment inspection
- Basic maintenance procedures
- Small equipment operation demonstrations
- Safety assessments

Week 10: Seasonal Crop Scheduling, Market Preparation, and Module Review

Lecture Topics

- Production scheduling
- Crop timing

- Inventory management
- Production planning fundamentals
- Harvest timing and techniques
- Plant quality standards
- Preparing plants for sale and transport
- Review of greenhouse and nursery operations

Learning Outcomes

Students will:

- Develop basic crop production schedules.
- Calculate production timelines.
- Understand inventory requirements.
- Harvest and prepare plants for market.
- Assess plant quality using industry standards.
- Demonstrate comprehensive greenhouse production skills.

Laboratory Activities

- Production calendar development
- Crop scheduling exercises
- Inventory assessment
- Production planning scenarios
- Plant quality evaluations
- Harvesting and handling exercises
- Plant labeling and preparation for sale
- Final practical skills assessment

D.3-4) Assessment Strategy

Assessment	Weight
Laboratory Participation and Skills	30%
Weekly Quizzes	10%
Crop Production Records & Logs	15%
Midterm Practical Assessment	15%
Production Planning Assignment	10%
Final Practical Examination	20%

D.3-5) Module Outcomes

Upon successful completion of this module, students will be able to:

1. Explain the principles of greenhouse and nursery crop production.
2. Operate and maintain greenhouse environmental control systems.
3. Select and use appropriate growing media and containers.
4. Establish, maintain, and monitor horticultural crops.
5. Implement irrigation, fertility, and crop maintenance programs.
6. Apply Integrated Pest Management practices in production environments.
7. Develop basic production schedules and inventory plans.
8. Operate greenhouse and nursery equipment safely.
9. Evaluate plant quality and prepare crops for market.
10. Demonstrate industry-standard greenhouse and nursery production skills suitable for entry-level employment in horticultural production operations.

E) Module Details for Professional Development Program in Applied Horticulture: Food Sustainability with Environmental Stewardship

E.1) Module name: <u>Sustainable Food Production</u>

E.1-1) Module Format

- **Duration:** 10 Weeks (May–July)
- **Schedule:** 1 Day per Week
- **Class Structure:** 1 Hour Lecture + 3 Hours Laboratory/Field Experience
- **Delivery Model:** Experiential Learning with lecture topics directly reinforced through practical activities
- **Focus:** Traditional food production, urban agriculture, sustainable growing practices, and emerging food production technologies

---

E.1-2) Module Description

This module introduces students to sustainable food production systems used in both traditional agricultural and urban environments. Students will explore the environmental, economic, and social aspects of food production while developing practical skills in crop cultivation, urban farming, season extension, soil management, food security, and emerging production technologies. Through hands-on laboratory and field-

based activities, students will gain experience growing food using a variety of methods while examining sustainable approaches to modern food systems.

E.1-3) Detailed weekly topics with learning outcomes & laboratory activities

Week 1: Introduction to Sustainable Food Production

Lecture Topics

- Food systems and food security
- Principles of sustainability
- Traditional vs. urban food production
- Local food systems

Learning Outcomes

Students will:

- Define sustainable food production.
- Explain the importance of local food systems.
- Compare traditional and urban production methods.

Laboratory Activities

- Site orientation
- Assessment of growing spaces
- Mapping a sustainable food production site
- Food system and food miles activity

Week 2: Soil Health and Sustainable Crop Production

Lecture Topics

- Soil composition and structure
- Soil ecology
- Organic matter and compost
- Soil conservation practices

Learning Outcomes

Students will:

- Explain the importance of soil health.

- Identify components of productive soils.
- Evaluate soil management practices.

Laboratory Activities

- Soil texture analysis
- Soil sampling and testing
- Compost assessment
- Building a compost pile or vermicomposting system

Week 3: Vegetable Crop Planning and Production

Lecture Topics

- Crop selection
- Seasonal production planning
- Crop rotation
- Companion planting

Learning Outcomes

Students will:

- Develop a basic crop plan.
- Select crops suited to local conditions.
- Explain crop rotation principles.

Laboratory Activities

- Garden planning exercise
- Crop layout development
- Seed selection
- Bed preparation and planting

Week 4: Seed Starting and Food Crop Establishment

Lecture Topics

- Seed germination requirements
- Direct seeding vs. transplanting
- Seedling care
- Establishment techniques

Learning Outcomes

Students will:

- Demonstrate proper seed-starting techniques.
- Monitor seedling development.
- Evaluate crop establishment success.

Laboratory Activities

- Seed sowing
- Plug tray production
- Germination monitoring
- Transplanting seedlings into production beds

Week 5: Urban Agriculture Systems

Lecture Topics

- Community gardens
- Rooftop gardens
- Balcony and patio production
- Container gardening

Learning Outcomes

Students will:

- Describe urban agriculture opportunities.
- Design small-scale food production systems.
- Evaluate challenges of urban growing.

Laboratory Activities

- Constructing container gardens
- Designing urban growing spaces
- Installing raised beds
- Crop establishment in limited-space environments

Week 6: Water Conservation and Irrigation

Lecture Topics

- Water requirements for crops
- Irrigation methods
- Rainwater harvesting
- Water conservation strategies

Learning Outcomes

Students will:

- Compare irrigation systems.
- Assess crop water requirements.
- Apply water conservation techniques.

Laboratory Activities

- Drip irrigation installation
- Soil moisture monitoring
- Irrigation scheduling exercises
- Rainwater collection system demonstration

Week 7: Sustainable Pest and Disease Management

Lecture Topics

- Integrated Pest Management (IPM)
- Beneficial insects
- Disease prevention
- Cultural management practices

Learning Outcomes

Students will:

- Identify common pests and diseases.
- Implement sustainable management strategies.
- Monitor crop health.

Laboratory Activities

- Pest scouting
- Beneficial insect identification
- Monitoring trap installation
- Plant health assessments

Week 8: Food Production in Controlled Environments

Lecture Topics

- Greenhouse food production
- High tunnels and hoop houses
- Season extension techniques
- Environmental controls

Learning Outcomes

Students will:

- Describe controlled environment agriculture systems.
- Explain methods of season extension.
- Operate basic environmental controls.

Laboratory Activities

- Greenhouse crop management
- Environmental monitoring
- Construction of low tunnels or row covers
- Crop growth assessments

Week 9: Hydroponic and Soilless Production Systems

Lecture Topics

- Principles of hydroponics
- Nutrient management
- Types of hydroponic systems
- Advantages and limitations

Learning Outcomes

Students will:

- Explain how hydroponic systems function.
- Compare soil-based and soilless production methods.
- Monitor hydroponic crop performance.

Laboratory Activities

- Hydroponic system setup
- Nutrient solution preparation

- EC and pH testing
- Crop monitoring and maintenance

Week 10: Emerging Food Production Technologies and Final Project

Lecture Topics

- Vertical farming
- Indoor agriculture
- Smart agriculture technologies
- Precision agriculture basics
- Food sovereignty and community resilience
- Sustainable food system models
- Career opportunities
- Module review

Learning Outcomes

Students will:

- Describe emerging food production technologies.
- Explain how technology can improve sustainability.
- Evaluate benefits and challenges of technology adoption.
- Evaluate sustainable food systems.
- Integrate module concepts into production planning.
- Demonstrate understanding of sustainable growing methods.
-

Laboratory Activities

- Vertical growing system demonstrations
- Environmental monitoring technology
- Sensor-based crop management exercises
- Technology evaluation project
- Final crop evaluations
- Sustainable food production project presentations
- Farm-to-table exercise
- Final practical skills assessment

E.1-4) Assessment Strategy

Assessment	Weight

Laboratory Participation and Skills	30%
Weekly Quizzes	10%
Crop Production Journal	15%
Food Production Plan Project	15%
Midterm Practical Assessment	10%
Final Practical Examination and Presentation	20%

E.1-5) Module Outcomes

Upon successful completion of this module, students will be able to:

1. Explain the principles of sustainable food production.
2. Grow food crops using traditional field and garden production methods.
3. Design and manage small-scale urban agriculture systems.
4. Implement sustainable soil, water, and nutrient management practices.
5. Apply Integrated Pest Management strategies to food crops.
6. Operate basic greenhouse, season extension, and controlled-environment production systems.
7. Demonstrate introductory skills in hydroponics and emerging food production technologies.
8. Harvest, handle, and prepare food products according to food safety standards.
9. Evaluate food system sustainability from environmental, economic, and social perspectives.
10. Develop a sustainable food production plan suitable for community, urban, or small-scale commercial production.

E.2) Module name: <u>Sustainable Environmental Principles in Horticulture</u>

E.2-1) Module Format

- **Duration:** 10 Weeks (May–July)
- **Schedule:** 1 Day per Week
- **Class Structure:** 1 Hour Lecture + 3 Hours Laboratory/Field Experience
- **Delivery Model:** Experiential learning with laboratories directly reinforcing lecture content
- **Focus:** Ecological horticulture, environmental stewardship, sustainable landscape and food production practices, and working with natural systems rather than against them.

E.2-2) Module Description

This module introduces students to the ecological principles that underpin sustainable horticultural systems. Emphasizing the philosophy of "working with nature rather than against it," students will explore how natural ecosystems function and how those principles can be applied to horticulture, food production, landscape management, and environmental stewardship. Through lectures, field observations, and hands-on activities, students will learn how biodiversity, soil health, nutrient cycling, water conservation, and ecological relationships contribute to healthier plants, reduced inputs, and more resilient production systems.

A central theme throughout this module is that successful horticulturalists learn to observe, understand, and cooperate with natural processes. Rather than relying solely on external inputs or corrective measures, students will develop the ability to use ecological relationships, biodiversity, healthy soils, and natural cycles to create productive and sustainable horticultural systems. This ecological mindset forms the foundation of both environmental stewardship and long-term horticultural success.

E.2-3) Detailed weekly topics with learning outcomes & laboratory activities

Week 1: Introduction to Ecological Horticulture

Lecture Topics

- What is sustainability?
- Working with nature versus controlling nature
- Ecology and horticulture
- Principles of environmental stewardship

Learning Outcomes

Students will:

- Define ecological horticulture.
- Explain the relationship between ecology and horticulture.
- Describe the benefits of sustainable management practices.

Laboratory Activities

- Site assessment of gardens or production areas
- Observation of natural and managed ecosystems
- Identification of ecological features within the landscape
- Environmental stewardship discussion and reflection exercise

---

Week 2: Understanding Ecosystems

Lecture Topics

- Ecosystem structure and function
- Food webs and food chains
- Producers, consumers, and decomposers
- Energy flow in ecosystems

Learning Outcomes

Students will:

- Describe how ecosystems function.
- Explain relationships between living organisms and their environment.
- Recognize the role of biodiversity in ecosystem health.

Laboratory Activities

- Ecosystem mapping exercise
- Food web construction
- Biodiversity surveys
- Habitat assessment project

Week 3: Soil Ecology and Living Soils

Lecture Topics

- Soil as a living ecosystem
- Soil microorganisms
- Organic matter and nutrient cycling
- Building healthy soils

Learning Outcomes

Students will:

- Explain the role of soil organisms.
- Assess soil health indicators.
- Understand nutrient cycling processes.

Laboratory Activities

- Soil sampling and evaluation
- Soil organism identification
- Compost analysis
- Earthworm population assessments

Week 4: Composting and Nutrient Cycling

Lecture Topics

- Natural decomposition processes
- Compost systems
- Carbon-to-nitrogen ratios
- Recycling nutrients within horticultural systems

Learning Outcomes

Students will:

- Explain nutrient cycling.
- Build and manage compost systems.
- Evaluate compost quality.

Laboratory Activities

- Compost pile construction
- Compost temperature monitoring
- Materials analysis
- Finished compost evaluation

Week 5: Biodiversity in Horticultural Systems

Lecture Topics

- Importance of biodiversity
- Monocultures vs. polycultures
- Beneficial insects and wildlife
- Habitat creation

Learning Outcomes

Students will:

- Describe ecological benefits of biodiversity.
- Identify beneficial organisms.
- Develop strategies to increase biodiversity.

Laboratory Activities

- Insect identification
- Pollinator surveys
- Biodiversity inventory
- Habitat enhancement project

Week 6: Water Conservation and Watershed Stewardship

Lecture Topics

- Water as a limited resource
- Watersheds and water cycles
- Water conservation strategies
- Rainwater harvesting

Learning Outcomes

Students will:

- Explain water movement through ecosystems.
- Assess water conservation opportunities.
- Implement water-saving practices.

Laboratory Activities

- Water-use audit
- Soil moisture monitoring
- Rainwater collection demonstration
- Irrigation efficiency assessment

Week 7: Ecological Pest Management

Lecture Topics

- Understanding pest ecology
- Integrated Pest Management (IPM)
- Predator-prey relationships
- Prevention versus treatment

Learning Outcomes

Students will:

- Explain ecological approaches to pest management.

- Identify common beneficial insects.
- Develop preventative management strategies.

Laboratory Activities

- Pest and beneficial insect scouting
- Monitoring trap installation
- Pest life-cycle observations
- IPM planning exercise

Week 8: Native Plants and Ecological Landscaping

Lecture Topics

- Importance of native species
- Ecosystem services
- Sustainable landscape design
- Habitat restoration

Learning Outcomes

Students will:

- Identify native plant species.
- Explain ecological benefits of native plants.
- Incorporate native species into horticultural designs.

Laboratory Activities

- Native plant identification
- Landscape assessment
- Ecological planting plans
- Habitat restoration project

Week 9: Climate Change, Ecosystem Services, Environmental Stewardship and Horticulture

Lecture Topics

- Climate impacts on horticulture
- Weather versus climate
- Building resilient growing systems
- Adaptive management strategies
- Pollination services
- Soil formation

- Carbon sequestration
- Human responsibility in environmental stewardship

Learning Outcomes

Students will:

- Describe climate-related challenges facing horticulture.
- Identify practices that improve system resilience.
- Evaluate adaptation strategies.
- Describe major ecosystem services.
- Explain how horticultural practices can support environmental health.
- Evaluate stewardship practices.

Laboratory Activities

- Climate data analysis
- Microclimate assessment
- Shade and wind protection evaluations
- Climate adaptation planning exercise
- Pollinator habitat assessment
- Carbon storage discussion and calculations
- Ecosystem service inventory
- Stewardship action plan development

Week 10: Sustainable Food Production Systems, Final Project and Module Review

Lecture Topics

- Permaculture principles
- Agroecology
- Companion planting
- Ecological food production systems
- Integrating ecological principles into horticulture
- Sustainable decision-making
- Career pathways in environmental horticulture
- Module review

Learning Outcomes

Students will:

- Explain the principles of agroecology and permaculture.
- Apply ecological design principles to food production.
- Assess sustainability within production systems.
- Demonstrate an understanding of ecological horticulture principles.

- Apply sustainability concepts to real-world horticultural situations.
- Develop management strategies that work with natural systems.

Laboratory Activities

- Companion planting demonstrations
- Permaculture design exercise
- Food production system assessment
- Ecological garden planning project
- Student sustainability projects
- Site improvement recommendations
- Group presentations
- Final practical assessment and module review

E.2.4) Assessment Strategy

Assessment	Weight
Laboratory Participation and Field Activities	30%
Weekly Quizzes	10%
Ecology Observation Journal	15%
Midterm Practical Assessment	15%
Sustainable Site Assessment Project	10%
Final Project and Presentation	20%

E.2-5) Module Outcomes

Upon successful completion of this module, students will be able to:

1. Explain ecological principles relevant to horticultural systems.
2. Apply environmental stewardship practices to horticulture and food production.
3. Assess soil health, biodiversity, and ecosystem function.
4. Utilize composting and nutrient cycling strategies to enhance sustainability.
5. Implement water conservation and ecological pest management practices.
6. Incorporate native plants and habitat considerations into horticultural designs.
7. Evaluate the impacts of climate change on horticultural systems and apply adaptive strategies.
8. Apply principles of permaculture and agroecology to food and plant production.
9. Recognize and support ecosystem services within managed landscapes.
10. Develop horticultural management approaches that work with natural systems to create productive, resilient, and environmentally responsible growing environments.

E.3) Module name: Invasive Plant Management

E.3-1) Module Format

- **Duration:** 10 Weeks (May–July)
- **Schedule:** 1 Day per Week
- **Class Structure:** 1 Hour Lecture + 3 Hours Laboratory/Field Experience
- **Delivery Model:** Experiential learning with laboratory and field activities directly supporting lecture content.
- **Focus:** Understanding invasive plants, invasion ecology, impacts on native ecosystems, identification, monitoring, prevention, and management strategies.

E.3-2) Module Description

This module introduces students to the science and management of invasive plant species and their impacts on natural and managed ecosystems. Students will learn what defines an invasive plant, the biological characteristics that contribute to invasiveness, pathways of introduction and spread, and the ecological consequences of invasions. Emphasis is placed on understanding how invasive plants affect native plant communities, wildlife habitat, biodiversity, and ecosystem function. A central theme of this module is that invasive plants are not inherently "bad" plants; rather, problems arise when species are introduced into ecosystems where natural checks and balances are absent. Students will examine how healthy ecosystems function, why invasive species can gain an advantage over native plants, and how informed management can help restore ecological balance. By understanding plant ecology and ecosystem dynamics, students will become more effective horticulturalists and environmental stewards capable of making responsible land management decisions.Through classroom instruction, field observations, plant identification exercises, and management projects, students will develop practical skills in invasive plant monitoring, assessment, prevention, and control while gaining an appreciation for ecological stewardship and habitat conservation.

E.3-3) Detailed weekly topics with learning outcomes & laboratory activities

Week 1: Introduction to Invasive Plants

Lecture Topics

- Definitions: native, non-native, naturalized, and invasive species
- Historical movement of plants around the world
- Why invasive plants matter
- Introduction to invasion ecology

Learning Outcomes

Students will:

- Define invasive plant terminology.
- Differentiate between native and invasive species.
- Explain the ecological significance of invasive plants.

Laboratory Activities

- Campus and site surveys
- Identification of common native and non-native plants
- Mapping local plant communities
- Introduction to field journals

Week 2: What Makes a Plant Invasive?

Lecture Topics

- Characteristics of invasive species
- Rapid growth and reproduction
- Seed production and dispersal mechanisms
- Environmental adaptability

Learning Outcomes

Students will:

- Identify traits commonly associated with invasive plants.
- Explain why certain species become invasive.
- Recognize high-risk plant characteristics.

Laboratory Activities

- Seed and fruit examination
- Growth habit comparisons
- Plant trait analysis
- Species risk assessment exercise

Week 3: Plant Ecology and Competition

Lecture Topics

- Ecological niches
- Competition for resources
- Succession and ecosystem dynamics
- Plant interactions

Learning Outcomes

Students will:

- Explain how plants compete for resources.
- Describe ecological relationships within plant communities.
- Evaluate competitive advantages of invasive plants.

Laboratory Activities

- Vegetation surveys
- Resource competition demonstrations
- Light and spacing studies
- Native versus invasive growth comparisons

Week 4: Pathways of Introduction and Spread

Lecture Topics

- Global trade and transportation
- Horticulture as a pathway
- Human-assisted dispersal
- Natural dispersal mechanisms

Learning Outcomes

Students will:

- Identify major pathways for invasive plant introductions.
- Explain how invasive plants spread through ecosystems.
- Assess potential introduction risks.

Laboratory Activities

- Seed dispersal investigations
- Pathway mapping exercise
- Case study analysis
- Field observations of dispersal strategies

Week 5: Impacts on Native Plant Communities

Lecture Topics

- Biodiversity loss
- Habitat displacement
- Changes in plant community structure
- Ecological consequences

Learning Outcomes

Students will:

- Describe how invasive plants affect native species.
- Evaluate impacts on biodiversity.
- Recognize symptoms of ecological degradation.

Laboratory Activities

- Native plant inventory
- Invasive species impact assessment
- Vegetation transect surveys
- Habitat quality evaluations

Week 6: Impacts on Wildlife and Ecosystem Function

Lecture Topics

- Wildlife habitat alteration
- Food web disruptions
- Pollinator impacts
- Ecosystem services

Learning Outcomes

Students will:

- Explain how invasive plants affect wildlife.
- Describe impacts on ecosystem processes.
- Evaluate effects on pollinators and beneficial organisms.

Laboratory Activities

- Pollinator observations
- Wildlife habitat assessments

- Ecosystem function case studies
- Species interaction mapping

Week 7: Identification of Common Invasive Plants

Lecture Topics

- Regional invasive species of concern
- Identification techniques
- Plant morphology review
- Seasonal recognition characteristics

Learning Outcomes

Students will:

- Identify common invasive plant species.
- Use field guides and identification keys.
- Distinguish invasives from similar native species.

Laboratory Activities

- Field identification exercises
- Herbarium specimen examination
- Plant collection and documentation
- Development of an invasive species field guide

Week 8: Monitoring and Early Detection

Lecture Topics

- Importance of early detection
- Monitoring techniques
- Mapping infestations
- Reporting invasive species

Learning Outcomes

Students will:

- Conduct invasive species surveys.
- Record and interpret monitoring data.
- Develop monitoring plans.

Laboratory Activities

- Survey methodology practice
- Site mapping exercises
- Data collection activities
- Monitoring report preparation

Week 9: Prevention, Integrated Management and Biosecurity

Lecture Topics

- Prevention strategies
- Best management practices
- Nursery and horticultural industry responsibilities
- Public education and outreach
- Integrated management approaches
- Biological control concepts
- Long-term management planning
- Adaptive management

Learning Outcomes

Students will:

- Explain the importance of prevention.
- Develop biosecurity protocols.
- Identify practices that reduce invasive species spread.
- Develop invasive species management plans.
- Integrate multiple control methods.
- Evaluate management success.

Laboratory Activities

- Equipment cleaning procedures
- Biosecurity audits
- Risk assessment scenarios
- Educational material development
- Management plan development
- Biological control case studies
- Treatment monitoring
- Group management project

Week 10: Mechanical and Cultural Control Methods

Lecture Topics

- Hand removal techniques
- Mowing and cutting
- Grazing management
- Restoration planning
- Restoring native plant communities
- Re-establishment of biodiversity
- Stewardship and conservation
- Module review and future challenges

Learning Outcomes

Students will:

- Compare various non-chemical control strategies.
- Select appropriate management methods.
- Evaluate effectiveness of control measures.
- Describe the principles of ecological restoration.
- Recommend strategies for recovering invaded ecosystems.
- Demonstrate comprehensive knowledge of invasive plant management.

Laboratory Activities

- Mechanical removal demonstrations
- Site restoration planning
- Monitoring treated areas
- Management strategy evaluation
- Native species planting project
- Restoration site assessment
- Student presentations
- Final practical skills assessment

E.3-4) Assessment Strategy

Assessment	Weight
Laboratory Participation and Field Activities	25%
Weekly Quizzes	10%
Invasive Species Field Journal	15%
Plant Identification Assessment	15%
Invasive Plant Management Plan	15%
Final Practical Examination and Presentation	20%

E.3-5) Module Outcomes

Upon successful completion of this module, students will be able to:

1. Define invasive plant species and explain their ecological significance.
2. Identify biological and environmental characteristics that contribute to plant invasiveness.
3. Explain how invasive plants spread through natural and human-assisted pathways.
4. Assess the impacts of invasive plants on native plant communities, biodiversity, and ecosystem functions.
5. Identify common invasive plants found in horticultural, agricultural, and natural environments.
6. Conduct field surveys, monitoring, and mapping of invasive plant populations.
7. Apply prevention and biosecurity practices to reduce the spread of invasive species.
8. Evaluate mechanical, cultural, and integrated management strategies.
9. Develop invasive plant management and restoration plans.
10. Promote environmental stewardship by supporting healthy, diverse, and resilient native ecosystems.