



Greenhouse Management

Primary Career Cluster:	Agriculture, Food, & Natural Resources
Consultant:	CTEStandards@tn.gov
Course Code(s):	C18H17
Prerequisite(s):	<i>Principles of Plant Science and Hydroculture</i> (C18H30)
Credit:	1
Grade Level:	11
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture, Food, & Natural Resources courses
POS Concentrator:	This course satisfies one out of two required courses to meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the <i>Horticulture Science</i> program of study.
Aligned Student Organization(s):	FFA: http://www.tnffa.org
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/content/tn/education/career-and-technical-education/work-based-learning.html
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	048, 150, 448, and 950
Required Teacher Certifications/ Training:	While not required to teach the course, teachers who use a greenhouse facility or an outdoor lab (cold frame, nursery, etc.) that uses any type of chemical (with an EPA label) must have the Commercial Pesticide Applicators License for C10.
Teacher Resources:	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-agriculture-food-natural-resources.html Best for All Central: https://bestforall.tnedu.gov/

Course-At-A-Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st century skills necessary to be successful in career and in life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards which feed into intentionally designed programs of study.

Students engage in industry relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management.
- Participate in FFA career and leadership events (CDE/LDE) that align with this course including Agriscience Fair, Agricultural Communications, Agricultural Issues, Agricultural Sales, Extemporaneous Speaking, Floriculture, and Prepared Public Speaking.

Using Work-based Learning in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1.3** | Invite an industry representative site to talk about career opportunities and skills and training required for employment.
- **Standards 2.1-8.4** | Have students develop projects with or evaluated by a greenhouse manager.
- **Standards 9.1-9.2** | Visit virtually or in-person a hydroponic facility and discuss the advantage of using hydroponic production systems.
- **Standards 10.1-10.2** | Have a greenhouse manager evaluate student-developed production schedules.

Course Description

Greenhouse Management is an applied-knowledge course designed to prepare students to manage greenhouse operations. This course covers principles of greenhouse structures, plant health and growth, growing media, greenhouse crop selection and propagation, and management techniques. Upon completion of this course, proficient students will be equipped with the technical knowledge and skills needed to prepare for further education and careers in horticulture production. Greenhouse Management is a dual credit course with statewide articulation.

Course Standards

1. Introduction to the Greenhouse Industry

- 1.1 Impact and Advancements: Summarize the historical development of the greenhouse production industry. Analyze the **global nature of the horticulture industry** and explain the **economic impact and technological advancements** associated with the greenhouse industry.
- 1.2 Recordkeeping and SAE: Accurately maintain **an active recordkeeping system** and apply **proper financial recordkeeping skills** as they relate to a greenhouse industry. Demonstrate the ability to develop, analyze records, generate reports, and completing related applications and reports. (i.e., employment applications, efficiency reports, SAE applications, and profit and loss statements).
- 1.3 Safety: Apply the concepts of **occupational safety and safety prevention** and control standards by interpreting industry manuals information.
 - a. Assess and explain the concepts of the **worker protection standards**.
 - b. Review common laboratory **safety procedures for tool and equipment** operation in horticulture laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow **safety and operational procedures** in a lab setting and complete a safety test with 100 percent accuracy.

2. Greenhouse Design, Construction, and Components

- 2.1 Structures: Classify **structures** by comparing and contrasting their **controlled environment system** (greenhouse, high tunnel, cold frame, vertical farming, hydroponics, etc.), **and construction materials** including but not limited to frames, coverings, and glazing materials. Justify the selection of the structure's construction materials based on cost-effectiveness, stability, maintenance, and function.
- 2.2 Planning and Design: Describe **characteristics of successful greenhouses** and create a list of **factors for planning and designing greenhouse facilities**. Factors must include physical location, market potential, utilities, climatic conditions, and production goals.
- 2.3 Design: Create an annotated model representing research-based practices in **greenhouse planning and design** and justify the process outlined for specific crops. The design must

include at least the following items: structure materials, layout, lighting, bench arrangements, traffic flow, and physical location.

- 2.4 Structure Maintenance: Compare **general maintenance and upkeep requirements for a variety of greenhouses** in relation to the **type of structural framework** and associated systems. Explain prescribed **maintenance**, preventative maintenance, **monitoring, and troubleshooting schedules** for greenhouse facilities and equipment. Demonstrate the **mechanical skills needed** for the general maintenance and repair of greenhouse structures and associated systems:(such as framework, equipment, electric motors, basic wiring, plumbing, and general construction).

3. Growing Media

- 3.1 Types of Growing Media: Explain the **types and utility of the attributes of growing media**. Describe the **major components of soil** and other growing media, and identify basic physical and chemical **characteristics** including structure, texture, alkalinity, water holding capacity, and drainage.
- 3.2 Plant Nutrients and Formulations: Identify the **effects of soil and soilless compositions** (pH, organic matter content, and mineral content) on **plant health and growth**. Perform **basic soil sampling and testing techniques** and interpret test data to formulate corrective actions as needed.
- 3.3 Preparation of Growing Media: Explain the **principles of media preparation**; develop a **check sheet** to guide media preparation. Describe the purpose, methods, and importance of **sterilizing media**. Compare and contrast the **cost-effectiveness** of premix and personal mix media to soil mix.)

4. Plant Structure, Function, and Growth

- 4.1 Plant Identification: Apply concepts of **scientific taxonomy and industry-specific terminology** in distinguishing **different species and types of plants grown** in a controlled environment:
- common vegetable plants,
 - common bedding plants, and
 - common herb plants.
- 4.2 Plant Structure and Function: Determine the basic **plant structure components that affect plant growth and development**. Differentiate between the:
- relationship between form and function for major plant structures and
 - anatomical and physiological differences of specific plant species.

4.3 Processes for Plant Life: Explain the **interrelationships between light, temperature, and water to the plant life processes** (such as photosynthesis, respiration, and transpiration), plant growth, and maintenance.

4.4 Growth Regulators: Compare and contrast current industry approved **methods to regulate plant growth** including, but not limited to, environmental, physical, genetic, and chemical.

5. Plant Nutrition

5.1 Nutrient Requirements and Deficiencies: Analyze the **nutrient requirements of plants** and assess the importance of the 17 essential plant nutrients for plant health. Identify the **chemical and biological processes needed** to make nutrients available for growth and maintenance, and distinguish among **nutrient deficiency and toxicity signs and symptoms** in plants.

5.2 Fertilizer Safety: Determine the significant **safety hazards associated with fertilizer use**. Evaluate the use of different precautions for the prevention or management of hazards and evaluate the efficacy of prevention measures.

5.3 Fertilizer Application: Identify the basic **types of fertilizers and their applications** for greenhouse production crops. Differentiate the effects of **fertilizer ratios** on plant growth and health to hypothesize possible outcomes of each ratio. Calculate **proper formulations** of fertilizers based upon label directions using systems of equations. Demonstrate the ability to follow **fertilizer label procedures** precisely as they pertain to the selection, handling, application, storage, and disposal.

6. Plant Propagation

6.1 Plant Propagation Methods: Differentiate between the **methods of sexual and asexual plant propagation**. Compare and contrast the following **techniques of propagation**, explaining the **advantages and disadvantages** of each: cutting, budding, layering, sowing, germination rate calculation, and seed viability.

7. Environmental Control Systems

7.1 Controlled Environment Production: Assess the **procedures** required for **producing multiple commercial plant species in a controlled environment**, and apply these procedures to produce a variety of specific greenhouse crops. Evaluate **environmental factors that affect greenhouse crops** to justify management methods.

7.2 Climate Control Equipment: Evaluate the **greenhouse climate** and recommend the **proper climate control equipment** to maintain an **optimum growing climate**, including but not limited to ventilation, humidifiers, heating, cooling, and shading. Provide written justification for each recommendation.

7.3 Water Management: Demonstrate effective methods to meet **water requirements for healthy plant growth**. Examine and explain how water pH influences plant growth. Research from multiple technical texts the **function and operating principles of greenhouse irrigation systems** (such as misting, drip, and overhead systems) to meet watering requirements to maintain the optimum moisture level for a variety of plants.

8. Diseases, Disorders, and Pests

8.1 Identification, Prevention, Treatment, and Control: Determine the **economic and aesthetic impact of plant diseases, disorders, and pests**. Identify and diagnose the **symptoms** of common plant diseases, disorders, and pests, and summarize **methods of prevention, treatment, and control** by drawing evidence from informational texts and relevant scientific literature.

8.2 Pesticide Application: Identify the **types of pesticides** and their **applications** for greenhouse production. Research the **safety hazards associated with pesticide use** for multiple greenhouse pesticides. Calculate **proper formulations of pesticides** based upon label directions for specific pests by creating systems of equations that describe numerical relationships.

8.3 Pesticide Safety: Demonstrate the ability to follow **pesticide procedures** precisely according to **label and safety guidelines**, including selection, handling, personal protective equipment (PPE), application, storage, and disposal.

8.4 Integrated Pest Management: Evaluate the basic principles and assess the overall effectiveness of **integrated pest management (IPM)** for controlling greenhouse pests and diseases. Compare with **traditional chemical controls**.

9. Hydroponic Applications

9.1 Hydroponic Systems: Examine the types of **hydroponic systems** in **greenhouse crop production**. Describe **essential elements** of hydroponic systems; explore **recent trends and advancements** to design a hydroponic system for a specific greenhouse crop.

9.2 Soilless Media Systems: Compare **hydroponic and soil-based growing methods for providing nutrients to plants**. Summarize the **advantages and disadvantages** of using soilless media systems to evaluate the efficacy for specific crops.

10. Greenhouse Business Management

10.1 Business Operations: Debate **laws and regulations affecting horticulture businesses**. Demonstrate the **use of general business, recordkeeping skills, and spreadsheet skills** necessary to manage a horticultural business, including but not limited to marketing,

advertising, product displays, scheduling, inventory control, merchandise handling, price point projections, and profit and loss statements.

- 10.2 Production Schedules: Research, develop, and implement **greenhouse production schedules for a representative sampling of greenhouse crops** that includes at least the following: plant selection, plant material cost (seed, plug, cuttings), growth media, fertilizers, water, testing kits, pricing guides, profit margin, labor, and other expenses.

Standards Alignment Notes

References to other standards include:

- SAE: [Supervised Agricultural Experience](#): All Agriculture students are encouraged to participate in a Supervised Agricultural Experience program to practice and demonstrate the knowledge and skills learned in their agriculture courses.
- AFNR: [National Agriculture, Food, & Natural Resources \(AFNR\) Career Cluster Content Standards](#): Students engaged in activities outlined above should be able to demonstrate fluency in Standards ABS.03, ABS.07, CS, PS.01, PS.02, and PS.03 at the conclusion of the course.
- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
 - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.