Department of Education | Postsecondary, Workforce, CTE, and Military Readiness

May 2026

Precision Agriculture

Primary Career Cluster:	Agriculture
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	TBA
Prerequisite(s):	Agriscience (C18H19)
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 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 Technology in Production Agriculture 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/education/educators/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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	048, 150, 448, and 950
Required Teacher Certifications/Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-agriculture-food-natural-resources.html

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 and 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 career and leadership development events (CDE/LDE) that highlight job skill demonstration. These include, but are not limited to, Farm Business Management, Agricultural Communications, Agricultural Issues, Cooperative Development Challenge, Agricultural Technology and Mechanical Systems, Agronomy, or Land Evaluation.

Using a Work-Based Learning (WBL) 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 1.1-1.4** | Invite a guest speaker to discuss technology in agriculture.
- **Standards 3.1-3.5** | Invite a professional from the agriculture field to discuss the importance of precision agriculture.
- **Standards 6.1-10.4**| Integrated a project with a local industry partner to support various advancements in agriculture.
- Standard 9.1 | Discuss troubleshooting with an employee responsible for troubleshooting.
- **Standard 12.1** | Research careers in precision agriculture include the roles and responsibilities. Present to middle school students interested in this program.

Course Description

Precision Agriculture is an applied course that addresses the technological innovation in agriculture that thrives on new advances, sustainable practices, and secures future farms and farming communities. The course covers a wide range of topics in biotechnology, precision agriculture in the crop and livestock industry, and sustainable practices in the food and fiber industry. Upon completion of this course, students will have learned the basics of computer and data science in the agricultural industry.

Course Standards

1. Precision Agriculture History, Safety, and Security

1.1 Historical Development: Research and report on the **historical developments and current trends with agricultural technologies** (e.g., drones, soil sensors, variable rate technology) and **policies that impact precision agriculture**, including broadband and access to technology in rural areas and other infrastructure gaps. Analyze how precision agriculture has influenced, and might it continue to transform, agricultural practices, food systems, economies, and ecosystems.

1.2 Cybersecurity Prevention: Investigate and demonstrate ways to **protect a computer system from threats**. Implement common **cybersecurity prevention methods** for each scenario. Create and justify a procedure for each security scenario using evidence for each solution on technical texts and industry standards.

a. Physical security (e.g., lock doors, tailgating, biometrics, badges, key fobs, retinal)
b. Digital security (e.g., antivirus, firewalls, antispyware, user authentication, etc.)
c. User education, employee training, phishing awareness, digital hygiene
d. Principles of least privilege- ensuring users have only the access necessary for their role
e. Data destruction and disposal- explain the safe removal and wiping of data when decommissioning old equipment or systems

1.3 Mobile Device Security: Research and describe the most **common security threats and the best practices for protecting sensitive agricultural data**. Investigate and distinguish among the following **common prevention methods** to secure a mobile device.

a. Passcode lock protocol
b. Remote wipe and data recovery tools
c. Locator and anti-theft applications
d. Remote backup applications
e. Failed login attempts and lockout strategies
f. Antivirus software and OS patching to maintain device integrity and data privacy

1.4 Security Procedures: Research and explain the **essential features and requirements of common security procedures** used to protect system resources on a network. Utilize multiple resources and explain why it is important to know this information when developing a security procedure. Create a chart using real-world examples explaining essential features of common **security procedures used to protect agricultural networks and data**. Defend how these procedures protect system resources and why understanding them is vital when developing new digital tools or expanding smart farming operations.

1.5 Network Protocols: Analyze and compare various **network security protocols and services** used to protect digital infrastructure in agriculture. Create a table or chart that lists the purpose and distinguishing features of each protocol and service, including the **protocol name, purpose, key features, and application in an agricultural setting** (e.g., protecting weather station data or securing communication between smart irrigation systems).

1.6 Safety Protocol: Demonstrate a comprehensive understanding and application of **safety protocols in both physical and digital** agricultural environments in the following areas:

a. Equipment Safety: Evaluate established protocols for the safe operation and maintenance of precision farming equipment, including Unmanned Aerial Vehicles (UAVs), autonomous tractors, and sensing devices.
b. Internet and Network Safety (including AI): Research and create safe online protocol practices and responsible use of network-connected devices, including the ethical use of artificial intelligence (AI) systems in agriculture.
c. Cybersecurity Awareness: Research and interpret cybersecurity risks related to agricultural platforms, such as unauthorized access, system vulnerabilities, and misuse of cloud-based data storage. Create protocols for secure credentials, access permissions, and routine updates to protect sensitive farm data.
d. Security Threats: Research and describe threats such as social engineering, phishing, malware, and viruses, using agricultural contexts where possible.
e. End User: Understanding of the ramifications of end-user license agreements and terms of service associated with granting rights to personal data and media to other entities.

1.7 Security Risks: Identify and document **security risks associated with emerging agricultural applications and digital tools**. Evaluate the severity of the risk involved in each, including but not limited to:

a. recognizing threats (hacking, malware, and data leaks);
b. understanding federal and state laws (computer crime, data fraud, and abuse);
c. protecting sensitive farm data (encryption, secure user access, and confidentiality protocol); and
d. designing a recovery plan for system errors or catastrophic failures (cyberattacks, virus, or ransomware).

2. Urban Agriculture

2.1 Vertical Farming: Research and analyze the concept of **vertical farming**, including its design, technological advancements, and scalability for urban environments. Explore how **vertical farming maximizes crop production in limited space**, reduces the need for land and water resources, and improves year-round crop production.

2.2 Food Security Project:

a. Research **food security** and document key components.
b. Analyze the **role urban agricultural practices** can play in improving food access in underserved communities.
c. Use **GIS** (Geographic Information Systems) **tools** to identify areas with limited access to fresh food. Collect and interpret data related to **food production, population**

density, and nutritional needs to propose solutions to increase food access in an urban community, supported by mapped data and predictions.

d. Create a **map to show existing production sites and identify vulnerable points** in food distribution.
e. Showcase the **solution to decrease food insecurity** to the class. Share the analyzed data and explain how it affected the solution. Discuss the challenges.

2.3 Hydroponics Project:

a. Research the **principles of hydroponic farming,** including its efficiency in water and nutrient management, and its potential for urban settings.
b. Investigate and communicate the **use of Internet of Things (IoT) sensors in managing water and nutrients efficiently** and evaluate how these technologies support sustainable food production in urban environments.
c. Design a **simulated or small-scale IoT-based hydroponic system**, collect, and analyze real-time data, and use cloud platforms to visualize system performance and recommend improvements.
d. Present the **benefits and challenges of using smart hydroponic systems** in urban or limited-space environments. Share the analyzed data and explain how it affected the solution. Discuss the challenges.

3. Agricultural Robotics and Automation

3.1 Automation/Electronic Systems: Compare and contrast **agricultural automation technologies,** (e.g., GPS steering systems, variable rate seeding, planter unit controllers, spray boom and nozzle controllers, and boom leveling systems) to **improve accuracy, efficiency, and sustainability** in crop production. Chart how these automations **impact modern agriculture system functions and their role in precision farming**.

3.2 Boolean Conditions: Use various **data types** (e.g., Booleans, characters, integers, floating points, strings) in appropriate situations within a program (e.g., Booleans (e.g., true, or false) when working with selection, integers, and/or floats when performing math calculations, strings when working with text data). Construct **Boolean expressions using relational** (e.g., <, >, <=, >=, ==, and !=) **and logical operators** (e.g., AND, OR, and NOT) within a program.

3.3 Debugging: Identify common **issues in automated systems** (e.g. faulty sensors, incorrect logic, wiring errors), explain key parameters in automated systems, analyze methods to fix hardware and software problems, and document solutions in automated agricultural systems (e.g. checklist to solve for GPS-guided tractors, greenhouse climate systems, automated irrigation, livestock feeders).

3.4 Robotic Programming: Investigate and create a flowchart of a program for a **robotic system in the horticulture** (e.g., harvesting, planting, irrigation, and weeding) **and animal industry** (e.g., robotic feeding, milking, monitoring health, and managing waste). Create programs that utilize selection control structures (e.g., if statements and switch statements) to make decisions and execute different code paths based on conditions. Test, modify, and optimize the program.

3.5 Feedback Loops: Research **feedback loops** in a robotic system. Create a program that utilizes iteration control structures (e.g., while loops and for loops) to repeat code blocks until the conditions are met.

3.6 Troubleshoot: **Troubleshoot and maintain precision agriculture technologies** to ensure optimal performance and data accuracy.

3.7 Computer-Aided Design (CAD): Investigate the role of CAD **software in agricultural engineering**, including designing, components, structures, and layouts. Read and explain basic blueprint drawings. Create 2D and 3D models using CAD software of farm parts or structures (e.g., fence lines, barn floor plans, tractor parts, or a greenhouse). Export and prepare CAD files for further use in manufacturing processes like CNC machining, 3D printing, or laser cutting.

3.8 Automation vs Traditional: Analyze and describe the advantages and challenges of **automation over traditional farming** methods, highlighting costs and efficiency with labor and production speed, crop yield efficiency, environmental impacts, and enhanced sustainability. Explore funding sources to promote the adoption of agricultural technologies.

3.9 Economic Data: Research, collect, and analyze types of **economic data used in agriculture, including labor and crop yield efficiency, and trends in commodity and food markets**. Evaluate how robots and automation impact labor costs, production speed, and animal welfare.

3.10 Research and Design project: Research **agricultural automation** to address a challenge in agriculture.

a. Evaluate current limitations and challenges with automation in agriculture systems and find a solution that addresses a key challenge.
b. Utilize a CAD program to design a basic simulation of an automation system using concepts of sensors, robotics, and machine learning to explain how this might work.
c. Create parameters to organize a program to make it easier to follow, test, and debug.
d. Create a spreadsheet outlining initial investment cost, operational cost, expected gains, and returns on investment (ROI) to calculate the payback period.
e. Investigate the impacts on rural communities, and large and small farmers, animal welfare and sustainability of implementing automated systems.
f. Create a report and include graphs, charts, and a financial model and discuss the technological, and financial benefits of the proposed automated system.
g. Communicate and present the automated system and the findings to the class or a panel of industry personnel.

4. Machine Learning and Artificial Intelligence (AI) in Agriculture

4.1 Machine Learning: Investigate how **machine learning optimizes processes, increases efficiency, and improves outcomes** with production agriculture. Communicate how machine learning has revolutionized the agriculture industry.

4.2 Spreadsheets: Analyze data in **spreadsheets to support real-time insights and decision-making in farming systems**. Summarize and create agricultural datasets by **accurately differentiating rows and columns**. Use spreadsheet functions (e.g., filtering, sorting, formulas) to support **data analysis and forecasting** for farm operations, such as crop performance, yield, and input efficiency.

4.3 Remote Sensing Data: Demonstrate how to **collect and interpret data** from agriculture sensors. Utilize data analysis, **machine learning, and sensor networks to analyze and interpret data** collected through remote sensing technologies, such as drones, satellites, and IoT-enabled devices. Develop **algorithms to automate the monitoring process** and improve the accuracy of agricultural predictions.

4.4 Mapping of Precision: Analyze and interpret related **geographical data using a variety of systems and technologies,** including GIS, satellite imagery, and IoT sensor networks. Apply **data visualization tools and spatial analysis techniques to interpret geographic data**. Use **cloud computing platforms and databases** to store and process large datasets and present insights in an actionable format, such as maps and heatmaps.

4.5 Yield Monitoring: Research and create a model to show how **yield monitoring systems** measure and improve crop performance for both grain and non-grain crops. Research, analyze and explain how to **calibrate yield monitors, clean yield data, interpret yield maps, and analyze field variability**. Investigate and create a flow chart to demonstrate how **crop quality sensors provide real-time and post-harvest data** on factors like moisture, protein, and physical quality.

4.6 Crop Monitoring Prediction: Examine and evaluate **methods for crop monitoring**. Investigate **machine learning algorithms to analyze historical and real-time data** for predictive modeling of crop yields including:

a. sensor data from soil moisture levels, temperature, and plant health to build models that can forecast crop yields with higher accuracy; and
b. data supports such as yield mapping, input tracking, soil monitoring, and irrigation efficiency.

4.7 Livestock Management: Investigate and explain **IoT and remote sensing applications for livestock management**, including tracking, animal health, behavior, and environmental conditions. Utilize data to apply machine learning and AI for analysis of behavioral patterns and health data, enabling early disease detection, better feeding practices, and improved overall animal welfare. Apply predictive modeling to make data-driven decisions.

4.8 Weather Forecasting and Risk Mitigation: Assess the **global impact of American agricultural commodities on world food markets** and understand how **weather forecasting can mitigate risks associated with crop production**. Evaluate **weather data and climate models to predict and mitigate agricultural risks**. Use hypothetical weather data, extreme event scenarios, and global market trends to develop a risk mitigation strategy for a simulated farming operation to reduce financial losses from environmental factors.

4.9 Soil Health and Nutrient Management: Identify key indicators of soil health. Examine how IoT **sensors and digital tools collect and transmit soil data**. Analyze and evaluate **soil datasets to detect trends, deficiencies, and anomalies** and the impact nutrient management has on crop performance and environmental sustainability.

4.10 Supply Chain: Explain the steps in **farm-to-market supply chain and analyze key stages and inefficiencies**. Use data spreadsheets to track and **analyze production schedules, inventory levels, and delivery logistics,** and apply predictive modeling to anticipate supply and demand trends. Design a hypothetical solution to an existing supply chain to reduce waste and improve resource efficiency in agricultural distribution systems.

4.11 Prediction and Detecting: Research and apply **geographic and economic data** to identify, analyze, and solve real-world problems in agricultural systems, examining the relationship between agricultural components, economic factors, and global implications.

a. Examine components of the agriculture systems such as animal health, nutrition, genetics, and soil and water analysis and evaluate their impact on the local, state, and global economy. Examine case studies where these components have influenced productivity or sustainability.
b. Investigate the economic factors related to crop production and livestock practices in agriculture.
c. Explore how agricultural policy and market trends influence farmers' decision-making, pricing, and economic viability.
d. Create a report or model utilizing geographic data and economic data to predict agricultural outcomes, which applies techniques to evaluate soil health, crop yield, or livestock management in specific areas that will predict future trends and the impact of the local, state, and global economy.

4.12 Artificial Intelligence (AI): Explore how **AI and machine learning revolutionized agriculture** by enabling data analysis, predictive modeling, and automation, leading to optimized resource management, increased productivity, and reduced environmental impact.

4.13 Policies: Research and summarize key **historical and current public policies** that have influenced precision agriculture and agricultural systems. Analyze how these policies shape **farming practices, technology adoption, and sustainability goals**. Evaluate a specific agricultural policy and defend or challenge its impact through evidence-based reasoning.

4.14 Ethical Programming Practices: Research news articles and **legislation on AI and automation** in agriculture. Analyze and explain **ethical programming practices**, including but not limited to:

a. the issues of confidentiality,
b. privacy,
c. fraud and misuse,
d. liability,
e. copyright,
f. open-source software,
g. trade secrets, and
h. sabotage.

5. Remote Sensing and Internet of Things (IoT) in Farming

5.1 Remote Sensing: Investigate and explain the **role of sensors in agriculture** (e.g., soil moisture, temperature, pH, nutrients, GPS, drones, VRT, boom spraying, and weather sensors). Describe how sensors contribute to precision agriculture and sustainable farming practices.

a. Apply agronomic principles and field data to analyze and adjust planter controls, ensuring accurate seed population and placement on field variability.
b. Demonstrate how automatic boom leveling systems operate. Understand how programming can detect variables in the topography.

5.2 Geographic Information Systems (GIS): Investigate and apply **geographic and precision technologies to enhance agricultural productivity and sustainability**.

a. Examine the tools and components of precision technologies used in the agriculture industry, including GPS, GIS, sensors, and yield monitors.
b. Analyze and interpret trends in data collected utilizing geospatial technologies to make informed agricultural decisions.
c. Research the economic impact of utilizing precision technologies (e.g., GPS/GIS) in the agriculture industry.
d. Use maps and collect data utilizing geospatial technologies and tools.

5.3 Internet of Things (IoT): Investigate the **Internet of Things (IoT**) and evaluate different **methods of monitoring in the agriculture industry**, including traditional techniques and modern technological advancements, particularly in remote sensing and IoT.

5.4 Remote Monitoring: Evaluate the **benefits and limitations of using sensors** in different agricultural settings. Investigate and communicate the types of **remote monitoring systems used in various industries of agriculture**. Compare and contrast those and explain the **sustainable farming practices with these innovative advancements**. Investigate and create a chart with the **types of remote monitoring systems** used in agriculture. Compare these systems across different sectors (e.g., crop monitoring, and livestock management) and assess their impact on sustainable farming practices.

5.5 Precision Nutrient Management: Investigate **grid zone sampling techniques** in agriculture. Explain how **management zones** are determined based on soil health, crop data, and other factors. Identify and evaluate **nutrient-specific sensors and functions**. Understand how **nutrient VRT (Variable Rate Technology) equipment operates** for targeted nutrient application. Explain the function and application of equipment to precisely apply fertilizer on real-time data. Analyze the benefits of precision management on yield, cost, and sustainability.

6. Data Analysis in Agriculture

6.1 Data Driven: Explore how **decision support systems and agricultural data management services empower farmers** by providing timely and accurate information, facilitating data-driven decision-making, and enhancing overall farm profitability through improved crop management and resource allocation.

6.2 Data Sources: Research and **use different data sources** (e.g., GPS data, farm management software, weather and soil data, remote sensing, satellite imagery, proximal sensing, yield maps, IoT sensors, monitoring systems, livestock data, marketing data, and geospatial data) to gather comprehensive and actionable information.

6.3 Decision Making Decisions: Leverage programming libraries and application programming interfaces (APIs), such as pandas, Geopandas, GDAL, and Matplotlib, to **facilitate data analysis, visualization, and reporting capabilities, enhancing decision-making processes** in agriculture.

6.4 Data Analysis: Interpret agricultural data using charts, graphs, and mapping tools to support evidence-based decision-making. Use **spreadsheet tools** (e.g., pivot tables, formulas, and graphs) to **identify trends and correlations** in crop yield, input usage, or weather conditions. Evaluate data using mathematical or statistical concepts to summarize and support recommendations for farm management strategies.

7. Agricultural Data Management System

7.1 Telematic Systems: Define and identify examples of **telematic systems used in modern agriculture**. Investigate and communicate with **companies or platforms that provide telematic services**. Develop a report that shows how data flows from the **field to the device, and create a data dashboard for a farm** to show how telematics could improve productivity or solve a problem.

7.2 Benefits of Data: Research and evaluate the role and value of data in modern agriculture by identifying how **data collection, storage, and analysis** improve productivity, sustainability, and decision-making. Compare the effectiveness and reliability of different **data collection tools** based on farm size, crop type, and available resources. Discuss limitations such as data accuracy, equipment maintenance, and accessibility for small-scale operations.

7.3 Data Storage and Management: Research and explain **cloud-based versus local storage options** in terms of cost, security, and accessibility. Create a **protocol for best practices for file naming conventions, data categorization, and backup strategies** to maintain integrity and usability over time.

7.4 System Integration: Investigate how different **agricultural technologies and platforms communicate and integrate data**. Analyze challenges and solutions related to **interoperability between equipment brands, software tools, and data formats**. Research and communicate industry efforts to create **unified systems that support data exchange**.

7.5 Mobile Devices: Investigate and communicate how **mobile operating systems support agricultural applications and precision farming tools.** Compare these operating system features to determine **suitability in field use**. Explain why it is important to know this information when **installing and configuring an operating system**.

a. Open source vs. closed source operating systems

b. App availability from various sources (such as app store and market)
c. Screen orientation sensors to support accelerometer/gyroscope
d. Screen calibration for mobile device usability
e. GPS and geotracking used in farming apps to support mapping, fieldwork, and equipment monitoring

Standards Alignment Notes

References to other standards include:

- SAE for All: Evolving the Essentials: All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) 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 the activities outlined above should be able to demonstrate fluency in Standards ABS and CS 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.