Agriculture and Environmental Systems

Career Field Technical Content Standards

with
Academic Content Standards in
English Language Arts, Mathematics, Science and Social Studies

September 2008

Ohio Board of Regents
Department of Education

OhioCollegeTechPrep
Ready for College. Ready for Life.

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Program Description

Agriculture and Environmental Systems Career Field Standards

Foreword

The *Agriculture and Environmental Systems Career Field Technical Content Standards* form the curricular framework for Ohio College Tech Prep and career-technical education programs in the agriculture and environmental systems career field. This document reflects the career field framework outlined in Ohio Administrative Code 3301-61-03 (Criteria for Secondary Workforce Development Programs).

This document represents a collaborative effort of the following professional partners: the Ohio Department of Education's Office of Career-Technical and Adult Education, the Ohio Board of Regents, the Marketing Education Resource Center and the Ohio Resource Center at The Ohio State University. Secondary and postsecondary educators, along with business and industry professionals, also participated in the development of the technical content standards.

The *Agriculture and Environmental Systems Career Field Technical Content Standards* combine business and industry standards, academic content standards (English language arts, mathematics, science and social studies) and the business process framework to develop technical literacy in agriculture and environmental systems. The agriculture and environmental systems career field includes occupations that focus on animal science, biotechnology, business operations, engineering, environmental science, food science and plant science. The Agriculture and Environmental Systems Career Field is comprised of seven program areas leading to technically-based careers in:

- Agribusiness and production systems
- Agriculture and industrial power technology
- Animal science and management
- Biotechnology
- Food science and technology
- Horticulture
- Natural resource management

This document delineates benchmarks and indicators that outline the knowledge and skills needed for career success in the above seven program areas. It includes a) benchmarks and indicators that are common across the agriculture and environmental systems career field addressing critical workplace skills, including communication skills, technical skills, business processes, problem solving and critical thinking, leadership, and teamwork skills; and b) benchmarks and indicators that describe program area-specific occupational knowledge and skills.

In addition, benchmarks from the Ohio *English Language Arts Academic Content Standards*, the *Mathematics Academic Content Standards*, the *Science Academic Content Standards* and the *Social Studies Academic Content Standards* have been embedded, outlining the language arts, mathematics, science and social studies knowledge and skills associated with specific technical competencies.

The Agriculture and Environmental Systems document seeks to provide the basis for educational programming that will foster the development of what Doug Bush, vice president and chief information officer, Intel Corporation, refers to as the "T-shaped" employee. The T-shaped employee combines broad knowledge, insight and understanding of business processes, academic attainment and workplace readiness (the crossbar of the "T") with depth of knowledge and expertise in a career specialty (the post of the "T"). The "T-shaped" employee is needed to ensure that Ohio's agriculture and environmental systems workforce of tomorrow will be competitive in a global environment that requires specialized

skills in a broader context aimed at the innovation of new products and services in an ever-changing economy.

This document forms the basis for developing an integrated delivery system that provides opportunities for new and challenging programs and courses. It is hoped that the document will enhance and expand career-technical education, College Tech Prep and postsecondary degree programs in agriculture and environmental systems and related fields.

The document is available on the Internet at http://cms.osu.edu/standardshome.html and through the Ohio Department of Education career field initiative Web pages at www.education.ohio.gov.

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Acknowledgements

A number of individuals contributed their time and expertise to the development of the *Agriculture and Environmental Systems Career Field Technical Content Standards* document. Special thanks go to all business representatives and educators named in this document. Further acknowledgement is due to:

- David Burns, Executive Director, Secondary Education and Workforce Development, Ohio Department of Education;
- Jonathan Tafel, Vice Chancellor for Educational Linkages and Access, Ohio Board of Regents;
- Kathy Shibley, Director, Office of Career-Technical and Adult Education, Ohio Department of Education;
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- Isaac Kershaw, Assistant Director, Office of Career-Technical and Adult Education, Ohio Department of Education;
- Anthony Landis, Administrator, College Tech Prep and Carl D. Perkins Programs, Ohio Board of Regents;
- Deborah Roshto, Director, Office of Curriculum and Instruction, Ohio Department of Education.

The individuals listed above provided vision and implementation support for the *Agriculture and Environmental Systems Career Field Technical Content Standards* document and Ohio's Agriculture and Environmental Systems educational programs.

Also, special thanks are due to the following professional partners of this project:

- Steve Gratz, Consultant, Office of Career-Technical and Adult Education, Ohio Department of Education;
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The people listed above contributed significant research, subject matter expertise and facilitation to the development of the *Agriculture and Environmental Systems Career Field Technical Content Standards* document.

AGRICULTURE AND ENVIRONMENTAL SYSTEMS CAREER FIELD TECHNICAL CONTENT STANDARDS DOCUMENT

The development process for the *Agriculture and Environmental Systems Career Field Technical Content Standards* began in March 2006 with the convening of a futuring panel and culminated in January 2008 with the work of a panel of business representatives and educators focusing on academic correlation. Over the course of 2007, numerous business and industry representatives, as well as secondary and postsecondary educators from across Ohio, took part in the formal development process. The following summarizes the various stages of the development process.

Futuring Panel

March 2006

The Agriculture and Environmental Systems futuring panel brought together key educators and business representatives from across the state to advise the Ohio Department of Education and the Ohio Board of Regents on future trends impacting the Agriculture and Environmental Systems Career Field, and to suggest ways in which those trends could be incorporated into an agriculture and environmental systems career field technical content standards document.

Expert Writing Panels

February-May 2007

Based on guidance provided by the futuring panel, expert writing panels met to revise the 2003 edition of the *Agriculture and Environmental Systems Career Field Technical Content Standards.* Each panel reviewed the existing content standards, made editorial changes and updated document content.

Business Review Panels

August-September 2007

Fifty-one Ohio business and industry representatives participated on these panels. Drawn from diverse industrial sectors and regions of the state, the panels identified what agriculture and environmental systems employees should know and be able to do in seven agriculture and environmental systems program areas: agribusiness and production systems, agriculture and industrial power technology, animal science and management, biotechnology, food science and technology, horticulture, and natural resource management.

Educator Review Panels

September 2007

These panels were composed of a total of 35 representatives from secondary and postsecondary institutions across Ohio. The panels determined when the benchmarks should be addressed. In addition, the educator panels noted questions they had on decisions made by the business review panels and formulated suggestions for additions, deletions and editorial changes to the draft document.

Stakeholder Review Panel

October 2007

Thirty-one representatives from the business and education review panels addressed issues and concerns educators raised in the September 2007 meetings. Suggestions for additions, deletions and editorial changes were reviewed to ensure that the document provided a cohesive and deliverable set of benchmarks and indicators for agriculture and environmental systems professionals at both secondary and

postsecondary exit points. The review provided a forum to ensure that the final document facilitates the seamless education of students interested in pursing a career in agribusiness and production systems, agriculture and industrial power technology, animal science and management, biotechnology, food science and technology, horticulture, and natural resource management.

Academic Review Panel

January 2008

The academic review panel brought together secondary and postsecondary technical educators and academic educators to identify benchmarks from the *Ohio Academic Content Standards for English Language Arts, Mathematics*, *Science* and *Social Studies* that are embedded within the technical benchmarks and indicators. This incorporation of academic content standards with career field technical content standards provides an opportunity for instructional integration of content, helping to contextualize learning for students and providing the basis for collaboration across disciplines.

Agriculture and Environmental Systems Futuring Panel

March 2006

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Agriculture and Environmental Systems Stakeholder Panel

October 2007

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Agriculture and Environmental Systems
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January 2008

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Philosophy and Principles for Implementation

Ohio Career Field Initiative

The overarching framework for career-technical education in Ohio is outlined in the Ohio Revised Code and subsequent administrative rules, which specify career-technical programming based on 16 career fields. To view the full text of the rule, go to www.education.ohio.gov and keyword search: *CTAE Administrative Rules*. These fields provide the framework for an Ohio career field initiative that seeks to foster the educational shift needed to respond to the needs of a rapidly changing global environment.

A career field is a "grouping of occupations and broad industries based on commonalities" (see www.careerclusters.org). Career fields are the basis for developing both broad and specialized technical content standards that serve as a framework for curriculum, instruction, assessment and program design, addressing the needs of an entire industry and business sector. Ohio's 16 career fields align with national efforts to broaden career-technical education, integrate career-technical education with academic study and reflect the workforce needs of today and tomorrow. For today's students to be adequately prepared for tomorrow's workforce, they must have an education that:

- **incorporates a broad, long-term conception of work in combination with the depth of specialization skills;**
  Employees need a comprehensive understanding beyond a single occupational area. Occupationally-focused programming needs to be provided in a larger context, so students can generalize learning, make connections between education and work and adapt to changes in their careers. Workplace knowledge and skills are needed to prepare employees for collaborating and problem solving while contributing to the broader business process.
- **emphasizes the acquisition of strong academic knowledge and skills; and**
  Academic skills provide the foundation for career success. The integration of academic content standards with career field technical content standards helps to contextualize learning for students, making English language arts, mathematics, science and social studies relevant to students as a means to an important end—success at work and in life.
- **facilitates high-school-to-postsecondary transitions.**
  A lifetime of change means a lifetime of learning, including postsecondary education. Students need knowledge and skills for success in a variety of postsecondary options, including apprenticeships, industry credentialing through adult education, two- and four-year college degree programs and graduate school.

Ohio Career Field Technical Content Standards

Career field technical content standards outline the knowledge and skills needed for success within a career field, multiple program areas and, in some cases, areas of specialization. Validated by Ohio business and industry representatives in conjunction with Ohio educators, these standards form the basis for developing educational programming in Ohio secondary and postsecondary schools. The standards also serve as the framework for developing strong career program areas that connect secondary, adult and postsecondary education systems with the workplace.

While mirroring the diverse nature of each career field, all career field technical content standards documents will contain knowledge and skills that are common across the career field, as well as those that relate to specific career field program areas.

Additionally, academic benchmarks from Ohio's academic content standards for English language arts, mathematics, science and social studies are correlated with the career field technical content standards. The embedded benchmarks have been determined by business representatives and academic and technical educators from secondary and postsecondary institutions to be strongly related to specific benchmarks and indicators for the given career field.

Key features of Ohio career field technical content standards include:

1. Broad as well as specialized technical content;
2. Embedded benchmarks for the English language arts, mathematics, science and social studies academic content standards; and
3. Workplace readiness skills and knowledge (communications; safety, health and environment; problem solving and critical thinking; leadership, management and teamwork; information technology applications; ethics and legal responsibility; business foundations; and career development and employability).

Career Pathways

A key component of the Ohio Career Field Initiative is a career pathway or program area, which is a series of academic and technical, career-focused course work and other learning experiences leading to a career specialty and employment in a career field. Pathways and program areas facilitate a seamless transition from high school to postsecondary education (including apprenticeships, adult education, two- and four-year colleges and graduate school) and from postsecondary education to the workplace.

To effectively facilitate the transition from secondary to postsecondary education and a career, high school career pathways and program areas should encompass:

1. Challenging technical course work in a chosen career field, based on career field technical content standards;
2. Rigorous academics that meet Ohio's academic content standards and grade-level expectations;
3. Electives that relate to career objectives;
4. Instructional enhancements, such as experiential and authentic learning opportunities (e.g., work-based learning, mentorships, internships) and career-technical student organization participation;
5. Opportunities (when appropriate) for program and student certification and licensure;
6. Preparation for transition to further study that includes college readiness and opportunities to earn college credit while in high school;
7. Preparation for transition to employment with advancement opportunities; and
8. Performance targets that include high school academic and technical testing/exit and postsecondary entry/placement requirements

For additional information on the Career Field Initiative, including Ohio Career Field Technical Content Standards and Career Pathways, go to www.education.ohio.gov and keyword search: *career field initiative*.

Structure and Format

The *Agriculture and Environmental Systems Career Field Technical Content Standards* document is composed of a series of content standards, benchmarks and indicators as follows:

- A *Content standard* is an overarching goal or theme. Standards statements describe, in broad terms, what students should know and be able to do.
- *Benchmarks* are more specific statements of what all students should know and be able to do at a specified time in their schooling. Benchmarks are used to measure a student's progress toward meeting the content standard. Three types of benchmarks are used—Level 1 Secondary Benchmarks, Level 2 Secondary Benchmarks and Postsecondary Benchmarks.
- *Indicators* are the most specific statements of knowledge and/or skills that students will learn. Indicators follow each set of benchmarks and serve as checkpoints to monitor progress toward learning benchmarks. Although benchmarks are written for each level of an agriculture and environmental systems program, indicators are not. A single set of indicators apply to all three levels of benchmarks. Faculty delivering instruction at each program level will apply the indicator at the breadth and depth appropriate for that level of study.

Also included in the document are selected benchmarks from Ohio's Academic Content Standards for English Language Arts, Mathematics, Science and Social Studies that correlate with specific technical competencies. This incorporation of academic content standards with career field technical content standards provides an opportunity for instructional integration of content, helping to contextualize learning for students and providing the basis for collaboration across disciplines.

Benchmarks and indicators that are common across the career field and/or are critical for success in the agriculture and environmental systems career field are present in all seven program areas. These common benchmarks represent the sustaining characteristics of a career field and facilitate career readiness and long-term career success by:

- Providing the basis for effective collaboration, teamwork and communication across program areas;
- Laying the groundwork for successful transfer of knowledge and skills across program areas, thereby facilitating horizontal and vertical career success; and
- Equipping students and workers with the skills needed to transition to new and emerging careers throughout a working lifetime.

In the *Agriculture and Environmental Systems* document, benchmarks and indicators common across the career field focus on the following topics:

- Marketing;
- Sales and customer service;
- Management;
- Finance;
- Purchasing and inventory;
- Information management;
- Communication skills;
- Business leadership;
- Emotional intelligence;
- Business regulation, law and related issues;

- Research and analysis;
- Agrosecurity and biosecurity;
- Safety procedures;
- Stationary and mobile equipment maintenance;
- Equipment operation;
- Contaminants;
- Emergency response; and
- Hazardous materials management.

Program area benchmarks and indicators are specific to one or more program areas within the Agriculture and Environmental Systems career field. They differentiate the academic, technical and workplace knowledge and skills that prepare students for multiple occupational specialties within a program area. Therefore, they are more specific to the program area than those that apply to the entire career field.

The *Agriculture and Environmental Systems Career Field Technical Content Standards* are built around seven career program areas:

- Agribusiness and production systems;
- Agriculture and industrial power technology;
- Animal science and management;
- Biotechnology;
- Food science and technology;
- Horticulture; and
- Natural resource management.

Common and program-area-specific benchmarks and indicators form the basis for developing secondary and postsecondary programs, facilitating transition from one educational level to the next and to the workplace. Benchmarks and indicators required by each particular program area are noted on the 2008 Agriculture and Environmental Systems Content Standards Chart.

In the *Agriculture and Environmental Career Field Technical Content Standards*, educators have designated when benchmarks should be addressed – by the halfway point in a high school agriculture and environmental systems program, by the end of the 12th grade and by the end of an associate degree level. Definitions used to make these designations appear on the following page, followed by a sample illustrating the layout of an actual page within a content standard.

Definitions and Codes

Determined by Educator Panels

Benchmark Level:

Level 1 Secondary Benchmark	=	by the halfway point in a high school agriculture and environmental systems program
Level 2 Secondary Benchmark	=	by the end of grade 12
Postsecondary Benchmark	=	by the end of the associate degree program

Determined by Academic Review Panel

Correlated English Language Arts Academic Content Benchmarks
Benchmarks drawn from the *Ohio English Language Arts Academic Content Standards* that have been determined to be embedded in the corresponding technical competency

Correlated Mathematics Academic Content Benchmarks
Benchmarks drawn from the *Ohio Mathematics Academic Content Standards* that have been determined to be embedded in the corresponding technical competency

Correlated Science Academic Content Benchmarks
Benchmarks drawn from the *Ohio Science Academic Content Standards* that have been determined to be embedded in the corresponding technical competency

Correlated Social Studies Academic Content Benchmarks
Benchmarks drawn from the *Ohio Social Studies Academic Content Standards* that have been determined to be embedded in the corresponding technical competency

Sample

3. Business Operations

3.7 Communication Skills

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Halfway Point in High School Agriculture and Environmental Systems Program

Level 1 Secondary Benchmark:
Integrate a variety of communication techniques to gather and convey information to an individual or small group

End of Grade 12

Level 2 Secondary Benchmark:
Conduct a business meeting using decision-making techniques

Educator Panels

End of Associate Degree

Postsecondary Benchmark:
Use a variety of communication techniques to present information that persuades an audience

Indicators:

3.7.1 Apply techniques for participating in and/or facilitating a group discussion.
3.7.2 Apply active listening strategies.
3.7.3 Develop and deliver formal and informal presentations.
3.7.4 Articulate ideas and impact an audience through verbal and nonverbal communication.
3.7.5 Communicate directions in an organized manner appropriate to the audience.
3.7.6 Use consensus building techniques, including parliamentary procedure, to make decisions and to compile a summary of meeting minutes, conclusions and next steps.
3.7.7 Extract relevant, valid information from materials, and cite sources of information.
3.7.8 Develop reports and documents that organize information accurately and that employ formatting techniques for ease of use.
3.7.9 Select and use an appropriate channel for workplace communication.
3.7.10 Practice etiquette when using communication techniques.

Correlated English Language Arts Academic Content Standards

Benchmarks from the English Language Arts Academic Content Standards

- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)
- *Use style guides to produce oral and written reports that give proper credit for sources (e.g., words, ideas, images and information) and include an acceptable format for source acknowledgement.* (Research D, 8-10; Research D, 11-12)
- *Evaluate the usefulness and credibility of data and sources and synthesize information from multiple sources.* (Research C, 11-12)
- *Use a variety of strategies to enhance listening comprehension.* (Communication: Oral and Visual A, 8-10; Communication: Oral and Visual A, 11-12)
- *Select and use effective speaking strategies for a variety of audiences, situations and purposes.* (Communication: Oral and Visual C, 11-12)
- *Give informational presentations that contain a clear perspective; present ideas from multiple sources in logical sequence; and include a consistent organizational structure.* (Communication: Oral and Visual E, 11-12)

Agriculture and Environmental Systems Program Area Descriptions

Agribusiness and Production Systems
Applies animal, plant, and environmental sciences to the production, management, marketing, distribution and processing of agronomic crops and domesticated livestock. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Chemical business manager;
- Grain originator/export terminal inspector;
- Feed mill/grain elevator manager;
- Crop and livestock producer;
- Agriculture communication specialist;
- Agriculture educator;
- Animal or crop scientist;
- Agronomist and certified crop advisor;
- Agro-security specialist;
- Veterinarian.

Agriculture and Industrial Power Technology
Applies engineering principles to the operation, maintenance, diagnosis and repair of power equipment used in agriculture, construction, forestry, horticultural and mining applications. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Diesel technician;
- Dispatch/logistics manager;
- Design engineer;
- Fleet manager;
- Service manager;
- Field service technician;
- Inventory manager/purchasing agent;
- Operator safety trainer;
- Parts technician;
- Power equipment dealer.

Animal Science and Management
Applies principles of anatomy and physiology, nutrition, reproduction, health, genetics, and behavior to the production, management, marketing and training of domesticated animals. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Companion animal veterinarian;
- Veterinary technician and technologist;
- Veterinary pharmacologist;
- Veterinary dentist;
- Zookeeper;
- Kennel manager;
- Animal groomer;
- Animal behaviorist;
- Animal health products and feed distributor representative;
- Embryo transfer specialist.

Biotechnology
Applies principles of basic chemistry, organic chemistry, microbiology and genetics to plant and animal research. The focus of this research is to enhance the production and physical attributes of plants and animals as well as to generate animal and plant products used today in transportation, manufacturing, medicine, food production and environmental protection. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Animal/plant geneticist;
- Biomass conversion specialist;
- Lab research technician;
- Animal vaccine development technician;
- Plant disease specialist;
- Biofuels specialist;
- Biochemist/bioengineer;
- Microbiologist;
- Animal cytologist;
- Food safety technician.

Food Science and Technology
Focuses on the development and processing of safe, nutritious and economical food products. Applies principles of basic chemistry, organic chemistry, microbiology, biochemistry and research methodology to food product development, testing, quality assurance practices, processing, preservation and packaging. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Food processing engineer;
- Food quality assurance specialist;
- Product packaging specialist;
- Meat, dairy, poultry, egg inspector/grader;
- New product development technician;
- Laboratory technician;
- Quality control manager;
- Veterinary meat inspector;
- Allergen specialist;
- HACCP/sanitation specialist.

Horticulture
Applies principles of plant anatomy, nutrition, reproduction, genetics, health and artistic design to production, management, processing and marketing of ornamental plants, landscapes and floral designs. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Interior plantscape designer;
- Greenhouse manager;
- Floral designer;
- Arborist;
- Golf course superintendent;
- Landscape architect;
- Landscape crew foreperson;
- Plant breeder;
- Turfgrass specialist;
- Nursery operator/owner.

Natural Resource Management

Applies earth, life and physical sciences to the management of renewable and non-renewable resources. Focus is on the production, extraction, processing, protection, use and/or renewal of soil and water, non-domesticated animals and aquatic life, plants and trees, and mineral resources. Communications, business principles and leadership skill development are essential to the program. Sample occupations include:

- Soil conservationist;
- Marine biologist;
- Wildlife biologist;
- Conservation or environmental education specialist;
- Water quality engineer;
- Game warden;
- Environmental engineer;
- Land management specialist;
- Park ranger;
- Timber harvester.

2008 Agriculture and Environmental Systems Content Standards Chart

Content Standards and Topics	Program Areas						
	Agribusiness and Production Systems	Agriculture and Industrial Power Technology	Animal Science and Management	Biotechnology	Food Science and Technology	Horticulture	Natural Resource Management
1. Animal Science							
1.1 Nutrition	X		X				X
1.2 Body Systems	X		X				
1.3 Care and Management	X		X				X
1.4 Animal Health	X		X				X
1.5 Population Management	X		X				X
1.6 Animal Behavior	X		X				X
2. Biotechnology							
2.1 Laboratory Preparation and Maintenance				X	X		
2.2 Biological Chemistry				X	X		
2.3 Genetics	X		X	X	X	X	
2.4 Chromatography				X	X		
2.5 Molecular Biology Technology				X	X		
2.6 Cell Biology and Culturing Techniques				X	X		
2.7 Microbiology				X	X		
3. Business Operations							
3.1 Marketing	X	X	X	X	X	X	X
3.2 Sales and Customer Service	X	X	X	X	X	X	X
3.3 Management	X	X	X	X	X	X	X
3.4 Finance	X	X	X	X	X	X	X
3.5 Purchasing and Inventory	X	X	X	X	X	X	X
3.6 Information Management	X	X	X	X	X	X	X
3.7 Communication Skills	X	X	X	X	X	X	X
3.8 Business Leadership	X	X	X	X	X	X	X
3.9 Emotional Intelligence	X	X	X	X	X	X	X
3.10 Business Regulation, Law and Related Issues	X	X	X	X	X	X	X
3.11 Research and Analysis	X	X	X	X	X	X	X
3.12 Agrosecurity and Biosecurity	X	X	X	X	X	X	X

Content Standards and Topics	Program Areas						
	Agribusiness and Production Systems	Agriculture and Industrial Power Technology	Animal Science and Management	Biotechnology	Food Science and Technology	Horticulture	Natural Resource Management
4. Engineering							
4.1 Safety Procedures	X	X	X	X	X	X	X
4.2 Stationary and Mobile Equipment Maintenance	X	X	X	X	X	X	X
4.3 Equipment Operation	X	X	X	X	X	X	X
4.4 Engines		X				X	
4.5 Transmission of Power		X					
4.6 Hydraulic Systems		X					
4.7 Electrical and Electronic Systems		X					
4.8 Heating and Air Conditioning Systems		X					
4.9 Steering, Suspension and Traction		X					
4.10 Design and Estimate	X					X	X
4.11 Surveying and Mapping	X					X	X
4.12 Construction	X					X	X
4.13 Brick, Block and Concrete	X					X	X
4.14 Electrical	X					X	X
4.15 Water Distribution Systems	X					X	X
4.16 Fabricating Metal with Heat	X	X					
4.17 Fabricating with Cold Metals	X	X					
5. Environmental Science							
5.1 Soils	X					X	X
5.2 Water	X					X	X
5.3 Ecosystems	X		X			X	X
5.4 Contaminants	X	X	X	X	X	X	X
5.5 Air						X	X
5.6 Emergency Response	X	X	X	X	X	X	X
5.7 Energy	X	X					X
5.8 Water Use and Management (Hydrology)							X
5.9 Pollution Control				X			X
5.10 Solid Waste and Renewable Resource Management	X		X	X	X	X	X
5.11 Potable Water Treatment Operations							X
5.12 Wastewater Treatment Operations							X

Content Standards and Topics	Program Areas						
	Agribusiness and Production Systems	Agriculture and Industrial Power Technology	Animal Science and Management	Biotechnology	Food Science and Technology	Horticulture	Natural Resource Management
5. Environmental Science							
5.13 Hazardous Materials Management	X	X	X	X	X	X	X
5.14 Habitat Management and Restoration						X	X
5.15 Geographic Information Systems (GIS)							X
6. Food Science							
6.1 The Science of Food					X		
6.2 Quality Assurance					X		
6.3 Food Production and Processing					X		
6.4 Food Product Development					X		
6.5 Food Safety and Security					X		
7. Plant Science							
7.1 Plant Nutrition	X					X	X
7.2 Plant Reproduction	X					X	X
7.3 Pest Management	X					X	X
7.4 Plant Production and Management	X					X	X
7.5 Harvesting, Handling and Storage	X					X	X

Agriculture and Environmental Systems Career Field Standards

1. Animal Science

Standard Statement:
Learners apply principles of animal anatomy, physiology, genetics, behavior and nutrition to the research and development, selection and reproduction, health, and management of animals in a domestic and/or natural environment.

1.1 Nutrition

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Analyze the nutritional content of a ration and administer it to animals.

Level 2 Secondary Benchmark:
Formulate, prepare and administer a ration, and evaluate its effects on animals.

Postsecondary Benchmark:
Develop a feeding program for a population of specific animal species based on economics, nutrition and availability of feed.

Indicators:

1.1.1 Identify types, composition, quality and compatibility of feeds, feed additives and feed byproducts.

1.1.2 Determine the role of nutrients and the nutritional requirements (matter and energy) for different animal life processes (e.g., maintenance and homeostasis, growth, reproduction, lactation).

1.1.3 Analyze the nutritional content and quality of feeds (e.g., fiber, sodium, proteins, carbohydrates, lipids).

1.1.4 Identify and treat major nutrient deficiency and toxicity symptoms.

1.1.5 Describe possible toxins, pathogens and contaminants found in feedstuffs (biological and nonbiological) and their impacts on animals.

1.1.6 Determine feed efficiency in relation to cost and availability of feeds.

1.1.7 Formulate, prepare and investigate rations and diets for production, specialty markets, and special diets (e.g., natural, organic, liver diet, heart diet, kidney diet).

1.1.8 Select and implement feeding and watering practices and systems for varying populations and purposes (e.g., reducing waste).
1.1.9 Monitor and evaluate the performance of feeding systems and programs.
1.1.10 Determine the ecological relationships between feed and/or agronomic production systems and feed quality.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.* (Measurement F, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Find, use and interpret measures of center and spread, such as mean and quartiles, and use those measures to compare and draw conclusions about sets of data.* (Data Analysis and Probability D, 8-10)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)
- *Apply mathematical modeling to workplace and consumer situations, including problem formulation, identification of a mathematical model, interpretation of solution within the model, and validation to original problem situation.* (Mathematical Processes J, 11-12)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.* (Life Sciences B, 9-10)
- *Explain how processes at the cellular level affect the functions and characteristics of an organism.* (Life Sciences A, 11-12)
- *Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.* (Scientific Inquiry A, 9-10)
- *Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world.* (Scientific Ways of Knowing A, 9-10)

1.2 Body Systems

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Differentiate the functions of body systems.

Level 2 Secondary Benchmark:
Describe the interrelationships of the animal body systems.

Postsecondary Benchmark:
Analyze how each system affects animal performance in specific species.

Indicators:

1.2.1 Identify external anatomical parts and functions.
1.2.2 Identify the anatomy and describe the physiology of the digestive systems.
1.2.3 Identify the anatomy and describe the physiology of the nervous systems.
1.2.4 Identify the anatomy and describe the physiology of the skeletal systems.
1.2.5 Identify the anatomy and describe the physiology of the musculature systems.
1.2.6 Identify the anatomy and describe the physiology of the circulatory systems.
1.2.7 Identify the anatomy and describe the physiology of the integumentary systems (skin) and associated structures.
1.2.8 Identify the anatomy and describe the physiology of the respiratory systems.
1.2.9 Identify the anatomy and describe the physiology of the urinary systems.
1.2.10 Identify the anatomy and describe the physiology of the male and female reproductive systems.
1.2.11 Identify the anatomy and describe the physiology of the endocrine systems.
1.2.12 Identify the anatomy and describe the physiology of the lymphatic systems.
1.2.13 Identify the anatomy and describe the physiology of the mammary systems.
1.2.14 Compare and contrast variations of systems among species and their adaptive values.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

1.3 Care and Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Describe the fundamental care and management practices for animals; select, handle, mark and manage environmental conditions; and provide general care for a limited number of animals or animal species.

Level 2 Secondary Benchmark:
Describe comprehensive care practices for animals, and apply advanced management procedures to select, handle, mark and manage environmental conditions.

Postsecondary Benchmark:
Recommend animal care practices, and apply complex procedures while managing animals.

Indicators:

1.3.1 Identify, classify, evaluate and select animal species and/or breeds.

1.3.2 Recognize and determine the biotic and abiotic factors that impact the animals' environment (e.g., air, ventilation).

1.3.3 Describe and implement scientific concepts of animal welfare.

1.3.4 Apply and record animal identification procedures and requirements (e.g., tagging, tattooing, ear notching, banding, branding, painting, electronic microchip implanting).

1.3.5 Estimate the environment's carrying capacity and its impact on animal health.

1.3.6 Explain predator-prey relationships (e.g., predator control, species propagation, invasive species control), and implement measures to control predators when necessary.

1.3.7 Evaluate and perform animal care procedures during and following parturition (e.g., navel cord, afterbirth, colostrums, orphaned animals).

1.3.8 Identify, evaluate and perform general animal care and welfare procedures based on the animal's use, species and life stage (e.g., weaning, dehorning, castrating, trimming hooves, milking, weighing, grooming, dental cleaning, dental floating, nail trimming).

1.3.9 Perform sanitation and disinfection procedures for the animals' care and management.

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Use formulas to find surface area and volume for specified three-dimensional objects accurate to a specified level of precision.* (Measurement B, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Explain the interconnectedness of the components of a natural system.* (Life Sciences E, 11-12)
- *Describe the ethical practices and guidelines in which science operates.* (Scientific Ways of Knowing C, 9-10)
- *Explain how ethical considerations shape scientific endeavors.* (Scientific Ways of Knowing B, 11-12)

1.4 Animal Health

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify prevalent diseases and disorders across animal groups, and implement treatment and maintenance options to remedy an animal's health and welfare.

Level 2 Secondary Benchmark:
Evaluate animal conditions and implement treatment and maintenance options for species-specific diseases and/or disorders.

Postsecondary Benchmark:
Identify an animal's condition, and perform specialized animal health procedures.

Indicators:

1.4.1 Evaluate an animal's general condition using diagnostic methods (e.g., visual exam, physical exam, vital signs).
1.4.2 Describe diseases and disorders and their symptoms that are caused by microorganisms, parasites, genetic defects and environmental factors.
1.4.3 Identify signs of pain, distress, disease and allergic reactions.
1.4.4 Collect specimens to perform urinalysis, hematology, cytology, skin scraping and fecal sample examinations.
1.4.5 Produce diagnostic radiographs using x-ray equipment and image receptors.
1.4.6 Apply principles of image physics, and perform ultrasonography techniques.
1.4.7 Identify gastrointestinal ailments, neuromuscular disorders, respiratory diseases, blood disorders, and bone or joint problems.
1.4.8 Monitor and evaluate the quality of an animal's habitat (natural or artificial), and implement corrective methods as needed.
1.4.9 Identify types of immunity and immune responses, and maintain animal health through immunization.
1.4.10 Administer care to animals in case of accident or illness.
1.4.11 Classify pharmaceutical drugs, and describe the general characteristics of each type.

1.4.12 Describe the routes of administration for medications (e.g., intranasal, oral, IV, subQ, IM) and the process of drug absorption, distribution, metabolism, withdrawal and excretion.

1.4.13 Calculate pharmaceutical dosages and mixtures, administer drug treatments, and monitor potential problems associated with incorrect administration and common adverse effects.

1.4.14 Recognize normal and abnormal dental structures and conditions, identify teeth, and use dental terminology to accurately chart dental morphology.

1.4.15 Prepare a sterile surgical environment, prepare patients for surgery and conduct post-surgery procedures.

1.4.16 Describe the indications, advantages, disadvantages, effects on the body and associated adverse side effects of commonly used preanesthetic and anesthetic agents.

1.4.17 Practice techniques of anesthesia with both injectable and inhalant medications, and monitor parameters during anesthesia.

1.4.18 Explain zoonoses and communicable diseases common to humans and animals.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Apply various measurement scales to describe phenomena and solve problems.* (Measurement B, 11-12)

Correlated Science Academic Content Benchmarks

- *Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.* (Life Sciences B, 9-10)
- *Explain how processes at the cellular level affect the functions and characteristics of an organism.* (Life Sciences A, 11-12)
- *Demonstrate that waves (e.g., sound, seismic, water and light) have energy and waves can transfer energy when they interact with matter.* (Physical Sciences G, 9-10)

1.5 Population Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Differentiate reproductive processes across species, and determine the extent to which breeding programs can be implemented for an intended purpose or outcome.

Level 2 Secondary Benchmark:
Develop, implement and evaluate a reproduction and/or population management plan.

Postsecondary Benchmark:
Develop, implement and evaluate a comprehensive breeding and management plan that meets the intended use of the habitat and/or the specific business operation.

Indicators:

1.5.1 Determine the factors that influence estrus, gestation and parturition, and employ appropriate management practices.

1.5.2 Evaluate and employ breeding methods (e.g., artificial insemination, embryo transfer, natural selection, selective breeding, invitro fertilization).

1.5.3 Practice ethical and responsible animal population management (e.g., spaying, neutering, euthanasia, birth control, relocation, reintroduction, hunting).

1.5.4 Manipulate an animal's reproductive processes (e.g., sex-sorted semen, birth control, heat synchronization, nutritional flushing).

1.5.5 Select and implement reproductive management practices (e.g., male-to-female ratios, fertility, soundness for breeding, age and weight for breeding and timing, other requirements for breed and species integrity), and monitor embryos and fetuses.

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Use descriptive statistics to analyze and summarize data, including measures of center, dispersion, correlation and variability.* (Data Analysis and Probability B, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)
- *Apply mathematical modeling to workplace and consumer situations, including problem formulation, identification of a mathematical model, interpretation of solution within the model, and validation to original problem situation.* (Mathematical Processes J, 11-12)

Correlated Science Academic Content Benchmarks

- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain the interconnectedness of the components of a natural system.* (Life Sciences E, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Analyze how issues may be viewed differently by various cultural groups*. (People in Societies A, 11-12)

1.6 Animal Behavior

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Observe an animal's natural tendencies, and predict changes in behavior when the environment is changed.

Level 2 Secondary Benchmark:
Apply management practices to animals that result in desired behavioral changes.

Postsecondary Benchmark:
Apply management practices across a specific enterprise or natural entity that take into consideration the natural behavioral tendencies of animals and then modifies these tendencies where appropriate.

Indicators:

1.6.1 Describe the adaptations and special senses (e.g., sight, hearing, smell, touch) of animals and how they contribute to animal behavior.

1.6.2 Describe and identify innate animal behavioral traits (e.g., protection, ingestion, homing, sleeping, grooming, elimination, sexual, care-giving, combative, evasive, breed differences).

1.6.3 Manipulate an animal's behavioral and natural tendencies through appropriate management practices.

1.6.4 Determine how animals learn (simple and complex) and how interventions can be employed to reach a desired behavior.

1.6.5 Identify social relationships involved in behavioral adjustment and/or adaptation (animal-to-animal interaction, human-to-animal interaction).

1.6.6 Describe the animal's vocal, visual and chemical means of communication, and interpret the intent.

1.6.7 Identify behavioral abnormalities and their cause(s), and employ corrective action.

1.6.8 Identify and employ techniques to train and discipline animals for predictive behavior.

1.6.9 Handle and move animals (e.g., training, restraint, confinement) with regard for the safety of the animals and their handlers.

Correlated Science Academic Content Benchmarks

- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)

2. Biotechnology

Standard Statement:
Learners apply principles of chemistry, microbiology and genetics to plant and animal research. The focus of this research is to enhance the production and physical attributes of plants and animals as well as to generate animal and plant products used today in transportation, manufacturing, medicine, food production and environmental protection.

2.1 Laboratory Preparation and Maintenance

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Use aseptic techniques to protect media and test results.

Level 2 Secondary Benchmark:
Follow protocol for handling, preparing and using solutions and mixtures.

Postsecondary Benchmark:
Make precise solutions and mixtures for specific applications, and replicate the process.

Indicators:

2.1.1 Maintain a sterile environment (e.g., flame sterilization, heat, filtration, pressure, chemical).
2.1.2 Select and apply the appropriate glassware and equipment cleaning method for the intended use.
2.1.3 Prepare solutions and mixtures, applying the concepts of polarity, saturation and solubility.
2.1.4 Use precision weighing and measuring techniques (e.g., analytical balance, micropipette).
2.1.5 Select and apply appropriate sterilization methods for solutions and mixtures.
2.1.6 Use and maintain the integrity of stock reagents.
2.1.7 Select and utilize the appropriate storage method for solutions and mixtures, equipment, and biologicals.
2.1.8 Demonstrate aseptic laboratory techniques.

Correlated English Language Arts Academic Content Standards

- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Explain differences among accuracy, precision and error, and describe how each of those can affect solutions in measurement situations.* (Measurement A, 11-12)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct logical verifications or counter-examples to test conjectures and to justify or refute algorithms and solutions to problems.* (Mathematical Processes B, 11-12)

2.2 Biological Chemistry

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Differentiate organic and inorganic compounds.

Level 2 Secondary Benchmark:
Perform quantitative and qualitative biochemical assays (e.g., proteins, lipids, carbohydrates, nucleic acids and enzymes).

Postsecondary Benchmark:
Manipulate reactions in cellular metabolism, and explain the results.

Indicators:

2.2.1 Describe the properties of atoms and the formulation of compounds.
2.2.2 Identify compounds using both common and chemical nomenclature.
2.2.3 Apply the concepts of stoichiometry and the laws of thermodynamics to chemical reactions.
2.2.4 Identify the structure of cells and the functions of their components.
2.2.5 Identify components and describe the functions of nucleic acids, carbohydrates, lipids and amino acids.
2.2.6 Describe the metabolism (anabolic and catabolic) of nucleic acids, carbohydrates, lipids and amino acids, and describe the roles of enzymes in these reactions.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

Correlated Mathematics Academic Content Standards

- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain that cells are the basic unit of structure and function of living organisms, that once life originated all cells come from pre-existing cells, and that there are a variety of cell types.* (Life Sciences A, 9-10)
- *Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.* (Life Sciences B, 9-10)
- *Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.* (Physical Sciences B, 9-10)
- *Explain how variations in the arrangement and motion of atoms and molecules form the basis of a variety of biological, chemical and physical phenomena.* (Physical Sciences A, 11-12)

2.3 Genetics

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	

Level 1 Secondary Benchmark:
Use mono- and di-hybrid crosses to predict genotype and phenotype.

Level 2 Secondary Benchmark:
Model the molecular basis of genetic transfer.

Postsecondary Benchmark:
Use mechanisms of gene regulation to explain the resulting phenotype or phenotypes.

Indicators:

2.3.1 Predict and explain offspring genotypes and phenotypes using Mendel's Laws and Punnett Square.

2.3.2 Explain alternative forms of transmission (e.g., non-Mendelian inheritance).

2.3.3 Explain, model and predict the three-dimensional shape, bonding patterns (covalent and hydrogen bonds) and antiparallel nature of deoxyribonucleic acid (DNA).

2.3.4 Model the Central Dogma Theory (e.g., replication, transcription, translation).

2.3.5 Describe the processes involved in gene regulation (e.g., histone acytelation, RNA stability, co-translational modifications and post-translational modifications).

2.3.6 Describe the properties and molecular structure of peptide/protein (i.e. primary, secondary, tertiary, quaternary).

2.3.7 Discuss alternative types of gene expression (e.g., sex-limited, sex-linked, partial dominance, epistatic, pleiotropic).

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

Correlated Mathematics Academic Content Standards

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the genetic mechanisms and molecular basis of inheritance.* (Life Sciences C, 9-10)
- *Explain how processes at the cellular level affect the functions and characteristics of an organism.* (Life Sciences A, 11-12)
- *Explain how the molecular basis of life and the principles of genetics determine inheritance.* (Life Sciences C, 11-12)

2.4 Chromatography

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Perform basic liquid chromatography.

Level 2 Secondary Benchmark:
Use gel electrophoresis to separate nucleic acids and to determine molecular weight.

Postsecondary Benchmark:
Use the appropriate chromatographic technique to identify or separate compounds within a solution or mixture.

Indicators:

2.4.1 Explain basic chromatography theory, types and methods.

2.4.2 Perform and interpret electrophoresis of RNA, DNA and protein samples using agarose or acrylamide.

2.4.3 Perform and interpret gas chromatography using standard detectors (e.g., flame ionization detector, electron capture detector, thermoconductivity detector).

2.4.4 Perform and interpret liquid chromatography using columns (e.g., ion exchange, gel filtration, affinity, thin layer).

2.4.5 Perform and interpret centrifugation.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

Correlated Science Academic Content Benchmarks

- *Summarize the historical development of scientific theories and ideas within the study of life sciences.* (Life Sciences G, 11-12)
- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)
- *Explain that science and technology are interdependent; each drives the other.* (Science and Technology B, 9-10)

2.5 Molecular Biology Technology

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Precipitate DNA from a solution, and interpret the results.

Level 2 Secondary Benchmark:
Fingerprint DNA, and interpret the results.

Postsecondary Benchmark:
Create a recombinant DNA molecule.

Indicators:

2.5.1 Isolate nucleic acids.
2.5.2 Perform and interpret the results of restriction enzyme digests.
2.5.3 Perform and interpret the results of Polymerase chain reaction.
2.5.4 Perform and interpret the results of Southern or Northern Blot Analysis.
2.5.5 Perform and interpret the results of nucleic acid sequencing, and compare using a sequence database (e.g., Genebank).
2.5.6 Isolate, quantitate (e.g., Bradford assay) and characterize proteins (e.g., Western Blot analysis).
2.5.7 Perform cloning techniques (e.g., antibiotic resistance into a vector).
2.5.8 Transform and transfect with recombinant DNA, and detect and analyze product/cells using bioassays.

Correlated Science Academic Content Benchmarks

- *Summarize the historical development of scientific theories and ideas within the study of life sciences.* (Life Sciences G, 11-12)
- *Explain that science and technology are interdependent; each drives the other.* (Science and Technology B, 9-10)

2.6 Cell Biology and Culturing Techniques

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Conduct microscopic identification and propagation of cells.

Level 2 Secondary Benchmark:
Culture and preserve pure cell lines.

Postsecondary Benchmark:
Verify culture cell lines and determine the cause or causes of culture failures.

Indicators:

2.6.1 Compare and contrast prokaryotic and eukaryotic cells.
2.6.2 Isolate, propagate, harvest and characterize bacteria, fungi, yeast and viruses.
2.6.3 Isolate, propagate, harvest and characterize plant and animal cell lines.
2.6.4 Isolate, maintain and store (e.g., cryogenic, refrigeration) pure cultures.
2.6.5 Determine a suitable media for propagation.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

Correlated Science Academic Content Benchmarks

- *Explain that cells are the basic unit of structure and function of living organisms, that once life originated all cells come from pre-existing cells, and that there are a variety of cell types* (Life Sciences A, 9-10)

2.7 Microbiology

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Aseptically collect and prepare a sample (e.g., dry, wet, low water content).

Level 2 Secondary Benchmark:
Conduct a shelf-life study to determine physical change and biological growth.

Postsecondary Benchmark:
Use selective media to identify microorganisms and to test for pathogens.

Indicators:

2.7.1 Collect and test food, animal and plant samples.
2.7.2 Use serial dilutions to make plate counts.
2.7.3 Isolate organisms by streaking plates and by using selective media.
2.7.4 Incubate and identify colonies microscopically and/or macroscopically (e.g., colonial morphology, Gram stain, biochemicals).
2.7.5 Test for pathogens using ELISA.
2.7.6 Conduct a thermal death time study on an organism.
2.7.7 Test for protozoa (e.g., Trichomonas).
2.7.8 Identify and test for bacteria and tuberculi (e.g., mycobacterium, campylobacterium, Brucella, streptococcus, Salmonella, E. coli, Staphylococcus, Vibrio).
2.7.9 Test for viruses.
2.7.10 Explain virulence, pathogenicity and the factors that contribute to pathogenicity.
2.7.11 Use DNA to correlate an isolated pathogen from a food to a pathogen found in an animal.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)

Correlated Mathematics Academic Content Standards

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct logical verifications or counter-examples to test conjectures and to justify or refute algorithms and solutions to problems.* (Mathematical Processes B, 11-12)

3. Business Operations

Standard Statement:
Learners apply principles of economics, business management and marketing in both an entrepreneur/manager and an employee role to the leadership, planning, developing and analyzing of business enterprises related to agriculture, food and natural resources.

3.1 Marketing

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Promote a product or service using basic strategies for packaging, display and publicity.

Level 2 Secondary Benchmark:
Develop and market a product or service to maximize profits and to optimize cost.

Postsecondary Benchmark:
Maximize profits and optimize cost by developing a comprehensive marketing plan.

Indicators:

3.1.1 Select a target market and consumers.
3.1.2 Research product and service designs, and determine the technical feasibility of new products.
3.1.3 Conduct market research and analysis.
3.1.4 Select channels of distribution.
3.1.5 Set prices using supply and demand curves and commodity and non-commodity pricing.
3.1.6 Identify and evaluate methods of marketing products and services.
3.1.7 Promote products and services.
3.1.8 Develop public relations campaigns.
3.1.9 Select and implement a marketing option (e.g., cash sales, hedge, speculate, options, forward contract, government programs).
3.1.10 Identify and evaluate purchase options (e.g., finance options, lease, cash, rental).
3.1.11 Evaluate the benefits of commodity check-off programs.

Correlated English Language Arts Academic Content Standards

- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)
- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)
- *Evaluate the usefulness and credibility of data and sources and synthesize information from multiple sources.* (Research C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Solve and graph linear equations and inequalities.* (Patterns, Functions and Algebra F, 8-10)
- *Solve systems of linear equations involving two variables graphically and symbolically.* (Patterns, Functions and Algebra H, 8-10)
- *Apply algebraic methods to represent and generalize problem situations involving vectors and matrices.* (Patterns, Functions and Algebra D, 11-12)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Analyze how scarcity of productive resources affects supply, demand, inflation and economic choices.* (Economics A, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

3.2 Sales and Customer Service

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Use customer service and sales techniques to foster positive relationships with customers and to conduct sales.

Level 2 Secondary Benchmark:
Use sales techniques to close the sale of a product and/or service and to handle complex customer issues.

Postsecondary Benchmark:
Develop a customer service program and a sales presentation.

Indicators:

3.2.1 Identify key components for organizing a sale.
3.2.2 Develop sales goals and incentive programs.
3.2.3 Forecast sales and delivery times.
3.2.4 Prospect for new customers.
3.2.5 Discuss and evaluate the appropriateness of different sales techniques and approaches in specific situations.
3.2.6 Develop and conduct a sales presentation.
3.2.7 Utilize suggestive selling and selling-up techniques.
3.2.8 Build and develop customer relationships.
3.2.9 Apply appropriate questioning techniques to determine client needs and wants.
3.2.10 Provide product, warranty and maintenance education to the customer.
3.2.11 Complete sales transactions and close-out procedures (e.g., handle money, operate the cash register, scan bar codes, record sales, write orders and invoices).
3.2.12 Utilize follow-up activities and strategies, and provide post-sale service.
3.2.13 Handle customer complaints.

Correlated English Language Arts Academic Content Standards

- *Use a variety of strategies to enhance listening comprehension.* (Communication: Oral and Visual A, 8-10; Communication: Oral and Visual A, 11-12)
- *Select and use effective speaking strategies for a variety of audiences, situations and purposes.* (Communication: Oral and Visual C, 11-12)
- *Give persuasive presentations that structure ideas and arguments in a logical fashion, clarify and defend positions with relevant evidence and anticipate and address the audience's concerns.* (Communication: Oral and Visual D, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

3.3 Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select and organize resources to develop a product or a service to be rendered.

Level 2 Secondary Benchmark:
Analyze the performance of an enterprise, and reallocate resources to achieve goals.

Postsecondary Benchmark:
Develop a comprehensive business plan.

Indicators:

3.3.1 Evaluate management styles.
3.3.2 Explain the characteristics of business plans.
3.3.3 Develop business goals and objectives and mission statements.
3.3.4 Identify the organizational structures of businesses.
3.3.5 Plan operational capacity.
3.3.6 Develop a continuous-improvement management program.
3.3.7 Establish business relationships.
3.3.8 Document business activities.
3.3.9 Track a business plan's performance.
3.3.10 Assess a product's profitability.
3.3.11 Analyze operating results in relation to either a budget or the industry.
3.3.12 Perform human resources management functions (e.g., recruit, select, evaluate, terminate employees).
3.3.13 Identify crisis management techniques.

Correlated English Language Arts Academic Content Standards

- *Analyze the features and structures of documents and critique them for their effectiveness.* (Reading Applications: Informational, Technical and Persuasive Text A, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

- *Evaluate the usefulness and credibility of data and sources and synthesize information from multiple sources.* (Research C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Identify factors which inhibit or spur economic growth and cause expansions or recessions.* (Economics B, 11-12)

3.4 Finance

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Budget and monitor an enterprise's income and expenses.

Level 2 Secondary Benchmark:
Analyze an enterprise's fiscal status, and reallocate resources to maintain and/or increase profitability.

Postsecondary Benchmark:
Analyze the fiscal status of a multi-faceted enterprise, and reallocate resources to maintain and/or increase profitability.

Indicators:

3.4.1 Identify sources of capital, and explain considerations in selecting among them.
3.4.2 Analyze investment options (e.g., buy, lease, finance, risk).
3.4.3 Evaluate credit uses and options.
3.4.4 Evaluate and select banking services.
3.4.5 Budget resources (e.g., capital, human, financial, time).
3.4.6 Manage assets for optimum utilization.
3.4.7 Manage the risk of liabilities.
3.4.8 Maintain financial records, and interpret and analyze financial statements.
3.4.9 Determine the cost of doing business (e.g., personnel, depreciation, materials, freight, quality).
3.4.10 Calculate and analyze return on investment (ROI).
3.4.11 Forecast future budgetary needs.

Correlated English Language Arts Academic Content Standards

- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.* (Measurement F, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Analyze how scarcity of productive resources affects supply, demand, inflation and economic choices.* (Economics A, 11-12)
- *Explain the use of a budget in making personal economic decisions and planning for the future.* (Economics E, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

3.5 Purchasing and Inventory

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Maintain an accurate inventory of assets.

Level 2 Secondary Benchmark:
Manage inventory based on budgeting and sales forecasting.

Postsecondary Benchmark:
Evaluate and select an inventory control system.

Indicators:

3.5.1 Explain the nature and scope of purchasing.
3.5.2 Manage the bid process in purchasing..
3.5.3 Evaluate and select vendors.
3.5.4 Discuss types of inventory, and evaluate inventory control systems (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just-In-Time [JIT]).
3.5.5 Record inventory usage.
3.5.6 Calculate the costs of carrying and not carrying inventory.
3.5.7 Determine a cost-effective order method and economic reorder point for inventory.
3.5.8 Apply just-in-time concepts.
3.5.9 Perform logistics management.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.* (Measurement F, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

3.6 Information Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select and use a computer and a computer application for a specific purpose.

Level 2 Secondary Benchmark:
Integrate software applications, and use multiple software options to create a product, a document or a presentation.

Postsecondary Benchmark:
Maximize the options offered through using multiple applications to enhance the product, the document or the presentation being developed or delivered.

Indicators:

3.6.1 Utilize technology to maintain and monitor business records.
3.6.2 Conduct research using the Internet.
3.6.3 Create and utilize documents using word processors, spreadsheets, databases and electronic mail.
3.6.4 Conduct an oral and visual presentation using presentation software.
3.6.5 Create and post a basic Web page.
3.6.6 Utilize personal information management and productivity applications.
3.6.7 Operate geospatial technological systems (e.g., Global Positioning System [GPS], Geographical Information System [GIS]).
3.6.8 Adhere to common security guidelines for technology.

Correlated English Language Arts Academic Content Standards

- *Prepare writing for publication that follows an appropriate format and uses a variety of techniques to enhance the final product.* (Writing Processes F, 11-12)
- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)
- *Give presentations using a variety of delivery methods, visual displays and technology.* (Communication: Oral and Visual G, 8-10; Communication: Oral and Visual F, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)

3.7 Communication Skills

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Integrate a variety of communication techniques to gather and convey information to an individual or small group.

Level 2 Secondary Benchmark:
Conduct a business meeting using decision making techniques.

Postsecondary Benchmark:
Use a variety of communication techniques to present information that persuades an audience.

Indicators:

3.7.1 Apply techniques for participating in and/or facilitating a group discussion.
3.7.2 Apply active listening strategies.
3.7.3 Develop and deliver formal and informal presentations.
3.7.4 Articulate ideas and impact an audience through verbal and nonverbal communication.
3.7.5 Communicate directions in an organized manner appropriate to the audience.
3.7.6 Use consensus building techniques, including parliamentary procedure, to make decisions and to compile a summary of meeting minutes, conclusions and next steps.
3.7.7 Extract relevant, valid information from materials, and cite sources of information.
3.7.8 Develop reports and documents that organize information accurately and that employ formatting techniques for ease of use.
3.7.9 Select and use an appropriate channel for workplace communication.
3.7.10 Practice etiquette when using communication techniques.

Correlated English Language Arts Academic Content Standards

- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)
- *Evaluate the usefulness and credibility of data and sources and synthesize information from multiple sources.* (Research C, 11-12)
- *Use style guides to produce oral and written reports that give proper credit for sources (e.g., words, ideas, images and information) and include an acceptable format for source acknowledgement.* (Research D, 8-10; Research D, 11-12)
- *Use a variety of strategies to enhance listening comprehension.* (Communication: Oral and Visual A, 8-10; Communication: Oral and Visual A, 11-12)
- *Select and use effective speaking strategies for a variety of audiences, situations and purposes.* (Communication: Oral and Visual C, 11-12)
- *Give informational presentations that contain a clear perspective; present ideas from multiple sources in logical sequence; and include a consistent organizational structure.* (Communication: Oral and Visual E, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators*. (Data Analysis and Probability A, 11-12)
- *Communicate mathematical ideas orally and in writing with a clear purpose and appropriate for a specific audience.* (Mathematical Processes I, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the reliability and credibility of sources.* (Social Studies Skills and Methods A, 9-10)
- *Work in groups to analyze an issue and make decisions.* (Social Studies Skills and Methods D, 11-12)

3.8 Business Leadership

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Determine an appropriate leadership style for a specific situation, and apply it to the situation.

Level 2 Secondary Benchmark:
Use multiple leadership concepts to change situations and to enhance effectiveness during the change process.

Postsecondary Benchmark:
Lead a team effort.

Indicators:

3.8.1 Identify the purpose of leadership, the ethical dimensions of leadership, and the relationships between leaders and team members.
3.8.2 Identify leadership styles and traits of leaders,
3.8.3 Identify the impact of individual differences and different situations on the practice of leadership.
3.8.4 Assess strengths and weaknesses of leaders and team members, and employ team-building techniques.
3.8.5 Participate in and lead a small group with an interdependent task.
3.8.6 Think critically and use problem-solving skills to analyze complex and diverse concepts.
3.8.7 Use reasoning, judgment and imagination to create new possibilities in situations.
3.8.8 Manage time with organizational tools, and prioritize objectives, responsibilities and tasks.
3.8.9 Apply conflict resolution skills.
3.8.10 Recognize and reward others for their efforts and contributions.
3.8.11 Develop relationships with peer groups, support services and professional organizations.

Correlated English Language Arts Academic Content Standards

- *Use a variety of strategies to enhance listening comprehension.* (Communication: Oral and Visual A, 8-10; Communication: Oral and Visual A, 11-12)
- *Select and use effective speaking strategies for a variety of audiences, situations and purposes.* (Communication: Oral and Visual C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)
- *Work in groups to analyze an issue and make decisions.* (Social Studies Skills and Methods D, 11-12)

3.9 Emotional Intelligence

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Exhibit desirable personal and professional appearance, attitudes, behaviors, and work habits.

Level 2 Secondary Benchmark:
Exhibit techniques that control emotional reactions to people and situations.

Postsecondary Benchmark:
Make ethical decisions in specific situations and/or when working with others.

Indicators:

3.9.1 Conduct an interpersonal and intrapersonal inventory.
3.9.2 Identify how individual actions impact others.
3.9.3 Manage personal emotions, behavior and appearance to maintain professionalism.
3.9.4 Describe and exhibit appropriate, ethical behavior.
3.9.5 Accept and use constructive feedback to improve work habits.
3.9.6 Employ appropriate coping skills to prevent and handle workplace conflicts.
3.9.7 Recognize, respect and utilize the diversity among people and cultures.
3.9.8 Foster positive working relationships.

Correlated English Language Arts Academic Content Standards

- *Use a variety of strategies to enhance listening comprehension.* (Communication: Oral and Visual A, 8-10; Communication: Oral and Visual A, 11-12)
- *Select and use effective speaking strategies for a variety of audiences, situations and purposes.* (Communication: Oral and Visual C, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Analyze how issues may be viewed differently by various cultural groups.* (People in Societies A, 11-12)

3.10 Business Regulation, Law and Related Issues

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify and describe government regulations and societal issues related to a specific business enterprise or environmental project.

Level 2 Secondary Benchmark:
Determine the impact of government regulations and societal issues on an environmental project or on the performance of a business enterprise.

Postsecondary Benchmark:
Develop a compliance program that addresses governmental regulations and societal issues surrounding an environmental project or business enterprise.

Indicators:

3.10.1 Explain the nature and appropriateness of different types of business contracts.
3.10.2 Explain the purpose and impact of government regulations.
3.10.3 Identify local, state and federal regulations relative to compliance.
3.10.4 Assess business liability, and describe the consequences of noncompliance.
3.10.5 Adhere to business related documentation requirements.
3.10.6 Identify governmental agencies and non-governmental organizations that impact agriculture and environmental issues.
3.10.7 Research the history, politics and policies related to issues.
3.10.8 Assess the impact of issues affecting the industry, and recommend solutions.

Correlated English Language Arts Academic Content Standards

- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Analyze the features and structures of documents and critique them for their effectiveness.* (Reading Applications: Informational, Technical and Persuasive Text A, 11-12)

- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)
- *Obtain and evaluate information from public records and other resources related to a public policy issue.* (Social Studies Skills and Methods A, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

3.11 Research and Analysis

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Conduct a study or survey, select descriptive statistics, create graphical displays, and draw conclusions.

Level 2 Secondary Benchmark:
Conduct a problem-based study, applying scientific methodology and using descriptive statistics to communicate and support predictions and conclusions.

Postsecondary Benchmark:
Design and conduct an experiment or process improvement study, collect and interpret data, and use descriptive statistics to communicate and support predictions and conclusions.

Indicators:

3.11.1 Identify research problems, and structure a statistical experiment, simulation or study related to the problem.

3.11.2 Create a hypothesis, and set the probability of acceptance based on a review of valid literature.

3.11.3 Establish and implement procedures for systematic collection, organization and use of data.

3.11.4 Select and apply sampling methods that appropriately represent the population to be studied.

3.11.5 Create, interpret and use tabular and graphical displays and descriptive statistics to describe data.

3.11.6 Compute measures of central tendency and dispersion to interpret results and draw conclusions.

3.11.7 Describe the relationships among variables using correlations, and draw conclusions.

3.11.8 Draw conclusions based on observations and/or data analyses, and disseminate information to interested parties.

Correlated English Language Arts Academic Content Standards

- *Formulate open-ended research questions suitable for investigation and adjust questions as necessary while research is conducted.* (Research A, 8-10)
- *Formulate open-ended research questions suitable for inquiry and investigation and adjust questions as necessary while research is conducted.* (Research A, 11-12)
- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)
- *Communicate findings, reporting on the substance and processes orally, visually and in writing or through multimedia.* (Research E, 8-10; Research E, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators*. (Data Analysis and Probability A, 11-12)
- *Use descriptive statistics to analyze and summarize data, including measures of center, dispersion, correlation and variability.* (Data Analysis and Probability B, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Communicate mathematical ideas orally and in writing with a clear purpose and appropriate for a specific audience.* (Mathematical Processes I, 11-12)

Correlated Science Academic Content Benchmarks

- *Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations*. (Scientific Inquiry A, 9-10)
- *Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.* (Scientific Inquiry A, 11-12)

3.12 Agrosecurity and Biosecurity

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify agrosecurity and biosecurity risks for an enterprise.

Level 2 Secondary Benchmark:
Implement a security plan, addressing facility needs and tampering points.

Postsecondary Benchmark:
Develop a risk management plan that addresses agrosecurity and biosecurity.

Indicators:

3.12.1 Recognize sources and origins of agents that can contaminate processed and unprocessed food products.
3.12.2 Identify activities and biological agents that contribute to the risk of acquiring or preventing a specific disease.
3.12.3 Identify sources of biological and chemical tampering points.
3.12.4 Assess facility security, classify the level of risk and recommend improvements.
3.12.5 Assess biosecurity practices for sourcing of raw ingredients, and recommend improvements.
3.12.6 Implement biosecurity procedures to prevent cross-site contamination.
3.12.7 Screen and test animals and plant products for infectious agents or contamination.
3.12.8 Use biocontainment practices (e.g., quarantine, eradication) to manage pests and disease vectors.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

4. Engineering

Standard Statement:
Learners apply the principles of engineering related to power transmission, hydraulics, electricity, heating and cooling, and enhanced performance to equipment design, manufacture, operation, repair and service of technology in agriculture, food and natural resources. Learners will design, construct, manage and maintain structures and biological systems used in agriculture, food and natural resources.

4.1 Safety Procedures

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Follow safety procedures in general situations with basic tools and equipment, evaluate the work environment, and seek assistance to rectify the problem.

Level 2 Secondary Benchmark:
Follow safety procedures in specific situations with specialized tools and equipment, evaluate the situation, and take corrective action.

Postsecondary Benchmark:
Develop emergency management procedures, implement an approved safety policy and take corrective action.

Indicators:

4.1.1 Demonstrate knowledge of safety rules and regulations.
4.1.2 Interpret safety signs and symbols.
4.1.3 Model safe attitudes and behaviors (e.g., lifting, climbing).
4.1.4 Identify safety hazards, and take corrective measures.
4.1.5 Use safety equipment in accordance with established procedures.
4.1.6 Follow established procedures for the administration of first aid, and contact emergency medical personnel when necessary.

Correlated English Language Arts Academic Content Standards

- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

4.2 Stationary and Mobile Equipment Maintenance

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Inspect and provide primary maintenance to basic machinery, instruments, stationary and mobile equipment and facilities.

Level 2 Secondary Benchmark:
Inspect and maintain specialized machinery and equipment according to schedule.

Postsecondary Benchmark:
Develop and implement a maintenance program.

Indicators:

4.2.1 Perform a machine condition inspection.
4.2.2 Lubricate machinery and equipment.
4.2.3 Ensure the presence and functionality of safety systems and hardware.
4.2.4 Service basic electrical systems (e.g., fuses and bulbs).
4.2.5 Perform machine adjustments (e.g., belts, clippers, drive chains).
4.2.6 Service filtration systems.
4.2.7 Identify, select and maintain fluid levels.
4.2.8 Maintain machinery, equipment, instruments and facility cleanliness, appearance and safety.
4.2.9 Inspect and maintain fluid conveyance and storage components (e.g., hoses and lines, valves, nozzles).
4.2.10 Conduct preventative maintenance, and identify causes of malfunctions and failures.
4.2.11 Calibrate metering, monitoring and sensing equipment.
4.2.12 Inspect and maintain tooling.
4.2.13 Maintain lifting equipment (e.g., cranes, chains, slings).

Correlated English Language Arts Academic Content Standards

- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

4.3 Equipment Operation

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Inspect and safely operate precalibrated equipment.

Level 2 Secondary Benchmark:
Inspect and safely operate specialized equipment with some limitations to adjustments and functions.

Postsecondary Benchmark:
Inspect, adjust and use all operational adjustments and functions of equipment for a specific application.

Indicators:

4.3.1 Follow manufacturer's recommended operating procedures and adjustment specifications.
4.3.2 Describe the functions, limitations and proper use of equipment, equipment controls and instrumentation.
4.3.3 Perform pre-operation inspection and adjustments.
4.3.4 Perform appropriate startup, operating and shutdown procedures.
4.3.5 Identify, select and exhibit the desired application of hand and power tools.
4.3.6 Perform post-operating inspections and adjustments.

Correlated English Language Arts Academic Content Standards

- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

4.4 Engines

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	

Level 1 Secondary Benchmark:
Inspect and evaluate the components of internal combustion engines.

Level 2 Secondary Benchmark:
Diagnose and repair components of both small and large internal combustion engines.

Postsecondary Benchmark:
Evaluate the performance of and select different types of internal combustion engines for various applications.

Indicators:

4.4.1 Locate the name plate, and determine engine specifications.
4.4.2 Analyze and troubleshoot an engine.
4.4.3 Evaluate engine performance.
4.4.4 Describe the features, benefits and applications of engine types.
4.4.5 Describe the physical and mechanical principles of engine operation (i.e., motion, friction, thermodynamics).
4.4.6 Classify and select engine lubricants, cooling agents and fuels.
4.4.7 Identify and service and/or repair fuel/air system components.
4.4.8 Identify and service and/or repair ignition, starting and charging system components.
4.4.9 Identify and service and/or repair cooling system components.
4.4.10 Identify and service and/or repair lubrication system components.
4.4.11 Identify and service and/or repair an electronic control system.
4.4.12 Evaluate engine components to determine serviceability according to the manufacturer's specifications.
4.4.13 Repair and/or replace basic internal engine components.
4.4.14 Repair and/or replace external engine components.
4.4.15 Identify the requirements for engine servicing to maintain emission requirements.

Correlated English Language Arts Academic Content Standards

- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Explain differences among accuracy, precision and error, and describe how each of those can affect solutions in measurement situations.* (Measurement A, 11-12)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the movement of objects by applying Newton's three laws of motion.* (Physical Sciences D, 9-10)
- *Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems*. (Physical Sciences D, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

4.5 Transmission of Power

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Inspect and adjust drive train components.

Level 2 Secondary Benchmark:
Diagnose and repair power train components.

Postsecondary Benchmark:
Evaluate the performance of, diagnose, and repair and/or replace hydrostatics, gear driven and infinite speed power trains.

Indicators:

4.5.1 Perform calculations involving speed, torque and power relationships.
4.5.2 Analyze, diagnose and test hydrostatic transmissions.
4.5.3 Analyze, diagnose and test differentials and final drives.
4.5.4 Analyze, diagnose and test clutches and brakes.
4.5.5 Analyze, diagnose and test gear-type transmissions (i.e., power shift, synchronized and sliding gear).
4.5.6 Analyze, diagnose and test electronic power train control systems (and programmable parameters).
4.5.7 Analyze, diagnose and test air shift controls and pneumatics.
4.5.8 Analyze, diagnose and test auxiliary drives.
4.5.9 Describe the features, benefits and applications of mechanical power transmission components (e.g., belts, chains, gears, bearings, seals, universals).
4.5.10 Describe the physical and mechanical principles of power transfer (e.g., mechanical, hydraulic, pneumatic and electrical).
4.5.11 Describe the features, benefits and applications of mechanical transmission technologies (i.e., mechanical, hydraulic, pneumatic and electrical).
4.5.12 Remove, inspect, and replace and/or repair power train components.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Solve increasingly complex non-routine measurement problems and check for reasonableness of results.* (Measurement A, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Explain differences among accuracy, precision and error, and describe how each of those can affect solutions in measurement situations.* (Measurement A, 11-12)
- *Apply various measurement scales to describe phenomena and solve problems.* (Measurement B, 11-12)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the movement of objects by applying Newton's three laws of motion.* (Physical Sciences D, 9-10)
- *Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).* (Physical Sciences E, 9-10)
- *Explain how energy may change form or be redistributed but the total quantity of energy is conserved.* (Physical Sciences F, 9-10)
- *Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems*. (Physical Sciences D, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

4.6 Hydraulic Systems

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Identify, inspect and test hydraulic systems.

Level 2 Secondary Benchmark:
Diagnose, repair and rebuild hydraulic components.

Postsecondary Benchmark:
Evaluate the performance of different types of hydraulic systems.

Indicators:

4.6.1 Describe the physical and mechanical principles of hydraulics.
4.6.2 Describe the features, benefits and applications of types of hydraulic and hydrostatic systems.
4.6.3 Interpret symbols and schematic drawings.
4.6.4 Describe the application and operation of major components (e.g., pumps, motors, valves, cylinders, accumulators).
4.6.5 Analyze, diagnose and test operating systems.
4.6.6 Analyze, diagnose, test, and repair and/or replace fluid conveyance components (e.g., hoses, lines, fittings).
4.6.7 Analyze, diagnose and test electronic controls for hydraulic systems.
4.6.8 Evaluate system cleanliness.
4.6.9 Identify hydraulic fittings and ports.
4.6.10 Remove, inspect and replace major components.
4.6.11 Identify and measure flow rate, pressure and temperature.
4.6.12 Adhere to contamination control procedures.

Correlated English Language Arts Academic Content Standards

- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)
- *Analyze whether graphics supplement textual information and promote the author's purpose.* (Reading Applications: Informational, Technical and Persuasive Text C, 8-10)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.* (Measurement F, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the movement of objects by applying Newton's three laws of motion.* (Physical Sciences D, 9-10)
- *Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).* (Physical Sciences E, 9-10)
- *Explain how energy may change form or be redistributed but the total quantity of energy is conserved.* (Physical Sciences F, 9-10)
- *Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems*. (Physical Sciences D, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

4.7 Electrical and Electronic Systems

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Identify, inspect and test electrical systems.

Level 2 Secondary Benchmark:
Diagnose and repair electrical systems.

Postsecondary Benchmark:
Diagnose and repair electronic control and computerized systems.

Indicators:

4.7.1 Interpret symbols and wiring diagrams.
4.7.2 Analyze, diagnose and test electrical systems and components (e.g., charging, starting, lighting, accessories, ignition systems).
4.7.3 Analyze, diagnose, calibrate and test instrumentation and data acquisition systems (e.g., guidance systems [laser, GPS], spraying, planting, harvesting monitors).
4.7.4 Utilize electrical testing equipment.
4.7.5 Analyze, diagnose and test electric drive components (e.g., man lifts and portable generators).
4.7.6 Remove, inspect. and repair and/or replace electrical system components.
4.7.7 Describe the features, benefits and applications of electrical systems.
4.7.8 Apply principles of electricity to electrical systems and motors.
4.7.9 Describe features and components of a DATA BUS operating system.
4.7.10 Identify, analyze, diagnose and test electronic control systems, sensors and actuators.
4.7.11 Utilize an onboard diagnostic system.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Explain differences among accuracy, precision and error, and describe how each of those can affect solutions in measurement situations.* (Measurement A, 11-12)
- *Apply various measurement scales to describe phenomena and solve problems.* (Measurement B, 11-12)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)

Correlated Science Academic Content Benchmarks

- *Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems.* (Physical Sciences D, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

4.8 Heating and Air Conditioning Systems

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Inspect and test heating and air conditioning systems.

Level 2 Secondary Benchmark:
Diagnose and repair vehicle heating and air conditioning systems.*

Postsecondary Benchmark:
Diagnose and calibrate computerized climate control systems.*

Indicators:

4.8.1 Apply the physical and mechanical principles of heating and cooling to heating, ventilating and air conditioning (HVAC) systems.
4.8.2 Evaluate the performance of heating and air conditioning systems.
4.8.3 Interpret symbols and diagrams.
4.8.4 Describe the features, benefits and applications of manual and electronically controlled HVAC systems.
4.8.5 Analyze, diagnose and test heating and air conditioning system components.*
4.8.6 Remove, inspect, and repair and/or replace heating and air conditioning components.*
4.8.7 Evacuate and select a refrigerant to charge air conditioning systems.*

*MACS Certification required

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain how energy may change form or be redistributed but the total quantity of energy is conserved.* (Physical Sciences F, 9-10)

4.9 Steering, Suspension, and Traction

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Identify, inspect and test steering and braking systems.

Level 2 Secondary Benchmark:
Diagnose and repair steering, braking and suspension systems.

Postsecondary Benchmark:
Evaluate vehicle performance, and adjust steering, alignment, braking and suspension systems, including traction-control systems.

Indicators:

4.9.1 Evaluate traction, ballasting and weight transfer, including towing and trailering systems.
4.9.2 Evaluate vehicle stability (i.e., automatic leveling device, center of gravity, roll-over and wheel base).
4.9.3 Analyze, diagnose and test suspension systems.
4.9.4 Remove, inspect, and repair and/or replace suspension components.
4.9.5 Analyze, diagnose and test steering systems.
4.9.6 Remove, inspect, repair and/or replace, and align steering components, including tires and tracks.
4.9.7 Analyze, diagnose and test vehicle braking systems (e.g., electrical, hydraulic, mechanical, pneumatic).
4.9.8 Remove, inspect, and repair and/or replace braking system components.

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the movement of objects by applying Newton's three laws of motion.* (Physical Sciences D, 9-10)
- *Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems*. (Physical Sciences D, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

4.10 Design and Estimate

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Utilize the elements and principles of design for an agriculture application.

Level 2 Secondary Benchmark:
Design a basic agriculture application for a desired outcome.

Postsecondary Benchmark:
Develop and analyze a complex design for specific programmatic applications.

Indicators:

4.10.1 Identify, interpret and use symbols, lines, dimensions, views, sections, site plans, floor plans, specifications, common scales, detail drawings and abbreviations on drawings and prints.

4.10.2 Complete a site inventory and analysis (e.g., physical conditions, design needs, code requirements, environmental impact, utilities requirements).

4.10.3 Develop a program list, including intended use, budget, economics, customer wants and needs, and maintenance.

4.10.4 Apply the principles of balance, proportion and scale, focal point, emphasis, rhythm, harmony, and unity in creating a design.

4.10.5 Apply the elements of line, form, texture and color in creating a design.

4.10.6 Incorporate principles of design (e.g., space, scale, proportion, order), and apply organizational and spatial principles to a design.

4.10.7 Calculate the space requirements, and compute various attributes, including length, angle measurement, surface area and volume.

4.10.8 Prepare sketches, drawings, prints, specifications and construction details.

4.10.9 Use designing and drawing tools, including computer aided design (CAD) software and other industry-specific software.

4.10.10 Identify construction documents, common scales and specifications, and select materials used in construction or fabrication.

4.10.11 Estimate material, construction and equipment needs and costs.

4.10.12 Establish the sequential steps of construction and installation.

Correlated English Language Arts Academic Content Standards

- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)
- *Evaluate how features and characteristics make information accessible and usable and how structures help authors achieve their purposes.* (Reading Applications: Informational, Technical and Persuasive Text A, 8-10)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.* (Measurement F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)
- *Apply mathematical modeling to workplace and consumer situations, including problem formulation, identification of a mathematical model, interpretation of solution within the model, and validation to original problem situation.* (Mathematical Processes J, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Use appropriate data sources and geographic tools to analyze and evaluate public policies.* (Geography C, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

4.11 Surveying and Mapping

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Interpret maps and topographic site plans.

Level 2 Secondary Benchmark:
Use surveying equipment to construct a basic site plan.

Postsecondary Benchmark:
Use technological tools to develop maps and site plans.

Indicators:

4.11.1 Identify civil drafting symbols and abbreviations.
4.11.2 Read maps, topographic site plans, deeds, and/or aerial and/or satellite imagery.
4.11.3 Perform site measurements.
4.11.4 Integrate map and surveying data in Geographic Information System (GIS) or computer aided design (CAD).

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Analyze whether graphics supplement textual information and promote the author's purpose.* (Reading Applications: Informational, Technical and Persuasive Text C, 8-10)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates*. (Measurement D, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

- *Use trigonometric relationships to verify and determine solutions in problem situations.* (Geometry and Spatial Sense A, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Use appropriate data sources and geographic tools to analyze and evaluate public policies.* (Geography C, 11-12)

4.12 Construction

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify tools and materials, and perform operations fundamental to construction.

Level 2 Secondary Benchmark:
Construct a scale model to illustrate various construction components.

Postsecondary Benchmark:
Following a multifaceted design, construct a structure using all elements of construction.

Indicators:

4.12.1 Lay out, cut, smooth, shape and bore construction materials.
4.12.2 Join similar and dissimilar construction materials (e.g., wood to wood, wood to concrete, wood to steel).
4.12.3 Lay out, cut and install decks and/or floors
4.12.4 Lay out, cut, assemble and brace framing components (foundation, joists, plates, subfloor, stud, sills).
4.12.5 Lay out, cut and install stairs and steps.
4.12.6 Lay out, cut and install roof framing (top plates, ridge boards, common rafters, prefabricated roof trusses, fascia and soffit) and roof trim accessories (drip edges, flashing and vents).
4.12.7 Lay out and install roofing materials (shingles, shakes, metal).
4.12.8 Install exterior doors and window units with hardware.
4.12.9 Install exterior sheathing and siding with trim accessories (e.g., gutters and downspouts, posts and railings).
4.12.10 Install glass, rigid plastic panels and/or film plastic.
4.12.11 Insulate the facility (i.e., draft stops, weather stripping, thermal insulation and vapor barriers).
4.12.12 Analyze a surface's condition, and select and apply abrasives and fillers.
4.12.13 Contrast surface coatings, and apply under appropriate environmental conditions.
4.12.14 Contrast options, and install fencing.
4.12.15 Compare and contrast the structural properties, grades and types of construction materials (e.g., wood and wood products, metals, vinyls).

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)

4.13 Brick, Block and Concrete

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify the required tools and materials, and calculate the amounts needed for a project using bricks, pavers, blocks, stone or concrete.

Level 2 Secondary Benchmark:
Construct a project using bricks, pavers, blocks, stone or concrete.

Postsecondary Benchmark:
Following a multifaceted design, lay out and install a structure using bricks, pavers, blocks, stone or concrete.

Indicators:

4.13.1 Describe the physical properties of bricks, pavers, mortar, blocks, cement and concrete.
4.13.2 Explain the chemical reactions within and between materials.
4.13.3 Describe air ratio and slump.
4.13.4 Identify layout and elevations using measurements to scale.
4.13.5 Estimate the construction and materials cost for bricks, pavers, mortar, blocks, stone and concrete.
4.13.6 Lay out and construct forms and reinforce using steel, wire and other materials.
4.13.7 Mix, place and finish concrete and mortar.
4.13.8 Install footers, lintels, sills, poured walls, floors and accessories.
4.13.9 Install gravel and sand pads.
4.13.10 Install cut masonry (e.g., bricks, pavers, stone, concrete).
4.13.11 Install joints, and cure concrete.
4.13.12 Identify the composition of concrete, and describe the chemical reaction of curing.
4.13.13 Select curing, coloring and texturing additives for a specific purpose.

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.* (Physical Sciences B, 9-10)
- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)

4.14 Electrical

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify tools and materials, draw a wiring diagram of a circuit, and install the circuit.

Level 2 Secondary Benchmark:
Develop a schematic that illustrates the kind, number and location of outlets and switches in a wiring system, and install the design.

Postsecondary Benchmark:
Design and install an electrical system that serves multiple load devices.

Indicators:

4.14.1 Describe the theory of producing electricity (the relationships among amperes, volts and watts; ohms law).
4.14.2 Compare and contrast AC and DC electrical systems and system components.
4.14.3 Measure the amperage of AC and DC electrical systems and system components.
4.14.4 Calculate service requirements for electrical systems.
4.14.5 Describe distribution system components.
4.14.6 Determine the types of branch circuits needed in a wiring system.
4.14.7 Determine the kind, size, number and location of wiring system components (e.g., outlets, switches, lights, wire, circuit breakers, motors).
4.14.8 Prepare and connect wires with appropriate fasteners and anchors to receptacles, switches and fixtures, to standards of the electrical industry.
4.14.9 Explain the color coding of electrical connections.
4.14.10 Install and identify over-current protective devices.
4.14.11 Install and service low-voltage systems (e.g., control systems and lighting systems).
4.14.12 Calculate horsepower requirements and install electric motors (e.g., single phase, three phase).

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

4.15 Water Distribution Systems

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify tools and materials, design a water supply line with fixtures, and install it.

Level 2 Secondary Benchmark:
Design and install a basic water and wastewater distribution system using multiple zones.

Postsecondary Benchmark:
Design and install a complex water and wastewater distribution system that extends service, addresses excess system requirements, and uses multiple types of fixtures and zones.

Indicators:

4.15.1 Calculate daily water needs.

4.15.2 Identify the common components of a water distribution system, and describe their functions.

4.15.3 Describe the types and operating principles of pumps and controls used in water supplies.

4.15.4 Calculate water demand for specific applications.

4.15.5 Detect, test and repair problems in the water supply system.

4.15.6 Install and secure waste and drain lines and vents.

4.15.7 Install water supply and treatment systems with both plastic and metal components.

4.15.8 Perform pressure and leak tests on water supply and drainage systems.

4.15.9 Describe the types and sources of contamination in water supplies (i.e., fuel storage tanks, septic systems, pesticide mixing areas, hazardous waste, manure storage, livestock yard and silage effluent) and methods for disinfecting water.

4.15.10 Protect pipes from freezing and mechanical damage.

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates*. (Measurement D, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)
- *Predict how human choices today will determine the quality and quantity of life on Earth.* (Science and Technology A, 11-12)

4.16 Fabricating Metal with Heat

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Join and cut ferrous metals using oxyfuel and shielded metal arc.

Level 2 Secondary Benchmark:
Join and cut ferrous metals using oxyfuel, shielded metal arc and gas shielded metal arc.

Postsecondary Benchmark:
Fabricate metal using all elements of fabricating metal with heat.

Indicators:

4.16.1 Compare and contrast metal welding operating characteristics and performance (i.e., oxyfuel, shielded metal arc, gas metal arc, flux core arc, gas tungsten arc, plasma gas, air carbon arc).
4.16.2 Determine the properties, types and uses of metals.
4.16.3 Classify, select, handle and store electrodes, and match them to the job requirements based on the level of penetration desired and heat range.
4.16.4 Heat treat metals.
4.16.5 Identify and select the joint design and welding position.
4.16.6 Compensate for the effects of expansion and contraction forces when joining metals.
4.16.7 Join ferrous and nonferrous metals with oxyfuel.
4.16.8 Set up welding equipment (i.e., oxyfuel, shielded metal arc, gas metal arc, flux core arc, gas tungsten arc, plasma arc, air carbon arc).
4.16.9 Solder, braze and braze weld metals.
4.16.10 Use shielded metal arc welding to join and wearface metals.
4.16.11 Use gas shielded metal arc welding to join metals.
4.16.12 Cut metals using heat (e.g., plasma arc cutting, air carbon cutting, machine-guided oxyfuel).

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)

4.17 Fabricating with Cold Metals

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Cut, shape, edge and fasten sheet metal.

Level 2 Secondary Benchmark:
Cut, shape, form and join metal stock.

Postsecondary Benchmark:
Following a design, fabricate an object using all elements of cold metal construction.

Indicators:

4.17.1 Lay out, cut and shear metal.
4.17.2 Shape stock by bending, folding, cutting, drilling and filling.
4.17.3 Form and assemble metal by cutting, bending, rolling and seaming.
4.17.4 Edge metal by wiring, turning, beading and crimping.
4.17.5 Identify various methods of fastening sheet metal.
4.17.6 Fasten metal using a range of hardware (e.g., rivets, screws, bolts).
4.17.7 Process cold metals by tapping, threading, drilling, torquing and smoothing.
4.17.8 Analyze the surface condition, and select and apply abrasives and fillers.
4.17.9 Contrast surface coatings and apply them under appropriate environmental conditions.

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)

5. Environmental Science

Standard Statement:
Learners apply earth, life and physical sciences to the production, extraction, processing, protection, use and renewal of both renewable and non-renewable resources. Knowledge and skills may be applied to agriculture and horticultural crops, domesticated and native animals, native and managed forests and ecosystems, mineral and water management, waste and hazardous materials management, and energy conservation and use.

5.1 Soils

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Determine and analyze the physical, biological and chemical properties of soils and other plant growing media.

Level 2 Secondary Benchmark:
Utilize knowledge of soil characteristics and soil information resources to overcome any existing soil use limitations.

Postsecondary Benchmark:
Develop and implement an appropriate plan for soil uses.

Indicators:

5.1.1 Classify soil types based on composition (e.g., aggregate size, organic matter, texture).

5.1.2 Inventory soils and determine land use capabilities.

5.1.3 Interpret soil survey data to implement conservation practices.

5.1.4 Select techniques that reduce soil erosion and compaction, basing decisions on soil and land properties (e.g., no till, subsurface and watershed drainage).

5.1.5 Evaluate soil limitations (e.g., wildlife habitats, wetlands habitats, septic systems, drainage, agriculture and socioeconomic considerations, preservation easements).

5.1.6 Explain current and historical interactions between human activities and soils (e.g., wetlands use, urbanization, desertification, finite resources, habitat change, climate change).

5.1.7 Identify soil forming factors, and explain how they produce variability in soils.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Describe and interpret rates of change from graphical and numerical data.* (Patterns, Functions and Algebra J, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain how human choices today will affect the quality and quantity of life on earth.* (Life Sciences F, 11-12)
- *Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.* (Scientific Inquiry A, 9-10)

Correlated Social Studies Academic Content Benchmarks

- *Use appropriate data sources and geographic tools to analyze and evaluate public policies.* (Geography C, 11-12)

5.2 Water

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Assess water quality using basic indicators.

Level 2 Secondary Benchmark:
Analyze and interpret the biological, chemical and physical properties of water quality.

Postsecondary Benchmark:
Determine water quality according to industry standards, and recommend protection and restoration techniques.

Indicators:

5.2.1 Measure pH, dissolved oxygen (DO), biological oxygen demand (BOD), temperature and macroinvertebrate populations to determine water quality.

5.2.2 Measure hardness, nitrogen, phosphorus, vegetation and physical characteristics of lentic and lotic waters to determine water quality.

5.2.3 Explain the hydrological cycle (e.g., condensation, evaporation, transpiration) and how human activity impacts the cycle.

5.2.4 Explain the biotic and abiotic factors affecting water quality.

5.2.5 Monitor and analyze water quality and quantity.

5.2.6 Explain the interactions between human activities and the earth's hydrosphere (e.g., septic systems, desalinization, point and nonpoint sources of pollution).

5.2.7 Implement practices that maintain or improve water quality.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Apply various measurement scales to describe phenomena and solve problems.* (Measurement B, 11-12)
- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain how humans are connected to and impact natural systems.* (Life Sciences B, 11-12)
- *Explain how human choices today will affect the quality and quantity of life on earth.* (Life Sciences F, 11-12)
- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)
- *Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.* (Scientific Inquiry A, 11-12)

5.3 Ecosystems

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify ecosystems, and compare the components of ecosystems.

Level 2 Secondary Benchmark:
Inventory and evaluate the habitats of specific ecosystems.

Postsecondary Benchmark:
Determine conservation and restoration practices according to specific ecosystem characteristics.

Indicators:

5.3.1 Explain and illustrate basic ecological principles and cycles (e.g., nitrogen cycle, food web, energy pyramid).
5.3.2 Explain biotic (plant and animal) interactions with the abiotic (non-living) environment.
5.3.3 Differentiate between renewable and nonrenewable components of ecosystems.
5.3.4 Model positive environmental practices for sustainability of resources.
5.3.5 Inventory and evaluate the characteristics of different ecosystems (e.g., pond, stream, crop lands, open land, brush lands, grasslands, woodlands, wetlands).
5.3.6 Discuss restoration ecology and its role in repairing damaged landscapes.
5.3.7 Identify and contrast biomes globally.
5.3.8 Determine the factors that affect ecological succession.
5.3.9 Determine the impact that native and non-native invasive species have on ecosystems.

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain that many processes occur in patterns within the Earth's systems.* (Earth and Space Sciences B, 9-10)
- *Explain the flow of energy and the cycling of matter through biological and ecological systems (cellular, organismal and ecological).* (Life Sciences D, 9-10)
- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Relate how biotic and abiotic global changes have occurred in the past and will continue to do so in the future.* (Life Sciences D, 11-12)
- *Explain the interconnectedness of the components of a natural system.* (Life Sciences E, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)
- *Use appropriate data sources and geographic tools to analyze and evaluate public policies.* (Geography C, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

5.4 Contaminants

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Determine the presence of contaminants, and follow reporting procedures.

Level 2 Secondary Benchmark:
Assess the affected area, determine the source and type of contaminant, and respond appropriately.

Postsecondary Benchmark:
Identify and remediate contaminants according to industry standards.

Indicators:

5.4.1 Determine the types, sources and impact of natural and man-made contaminants (e.g., manure; wastewater; soil; agriculture, residential and industrial chemicals).

5.4.2 Explain and implement programs and policies related to contaminants.

5.4.3 Identify, comply with and implement contaminant control, remediation and prevention practices (e.g., biological, radiological, sanitation, buffer strips for run-off).

5.4.4 Monitor, analyze and evaluate levels of contaminants from a point source and a non-point source.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain how human choices today will affect the quality and quantity of life on earth.* (Life Sciences F, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

5.5 Air

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Measure levels of oxygen, carbon dioxide and particulate matter.

Level 2 Secondary Benchmark:
Assess air quality, and determine its impact on the environment.

Postsecondary Benchmark:
Establish techniques for monitoring and assessing air quality in a given environment.

Indicators:

5.5.1 Determine the chemical and physical properties of air (e.g., composition, density, pressure).

5.5.2 Explain chemical cycles and how they relate to the biosphere, geosphere and atmosphere (e.g., nitrogen cycle, oxygen cycle, sulfur cycle).

5.5.3 Explain human and natural factors affecting air quality (e.g., volcanic eruptions, forest fires, greenhouse gases, dust, farming practices).

5.5.4 Monitor and evaluate air quantity and quality.

5.5.5 Assess the potential for air contamination at a specific site.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Describe how Earth is made up of a series of interconnected systems and how a change in one system affects other systems.* (Earth and Space Sciences B, 11-12)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain how human choices today will affect the quality and quantity of life on earth.* (Life Sciences F, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

5.6 Emergency Response

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Comply with all the components of an emergency response plan.

Level 2 Secondary Benchmark:
Simulate the appropriate response to an emergency situation.

Postsecondary Benchmark:
Develop an emergency response plan.

Indicators:

5.6.1 Analyze factors that influence environmental conditions.
5.6.2 Identify responses to emotional, physiological and environmental stress.
5.6.3 Identify and implement various emergency response plans.
5.6.4 Identify and contact local emergency response teams.

Correlated English Language Arts Academic Content Standards

- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

5.7 Energy

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select energy sources and fuels according to their physical properties.

Level 2 Secondary Benchmark:
Select energy sources and fuels according to their economic viability, sustainability and environmental impact.

Postsecondary Benchmark:
Select traditional and alternative energy sources for efficiency and for their environmental impact on the local, regional and global levels.

Indicators:

5.7.1 Identify and compare fossil fuel energy sources.

5.7.2 Identify and compare renewable energy sources (e.g., biomass, methane, solar, wind, geothermal).

5.7.3 Identify and compare nuclear energy sources.

5.7.4 Calculate fuel equivalents between energy sources.

5.7.5 Trace the transformations of energy within a system (e.g., mechanical to electrical, chemical to mechanical).

5.7.6 Research sources of energy beyond traditional fuels, their known advantages and disadvantages, and any unintended consequences developing from their use.

5.7.7 Identify the environmental impacts of energy sources, and determine methods that lessen their environmental impact (e.g., carbon sequestration, conservation, efficiency).

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.* (Measurement F, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain how energy may change form or be redistributed but the total quantity of energy is conserved.* (Physical Sciences F, 9-10)
- *Predict how human choices today will determine the quality and quantity of life on (Earth.* (Science and Technology A, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)

5.8 Water Use and Management (Hydrology)

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify sources of water (e.g., surface water, soil water, bedrock water, aquifer).

Level 2 Secondary Benchmark:
Collect and interpret data for a localized water use and management plan.

Postsecondary Benchmark:
Develop a localized water use and management protection plan, based on existing data.

Indicators:

5.8.1 Explain hydrology.
5.8.2 Explain the geological and meteorological principles affecting groundwater supply.
5.8.3 Conduct a channel flow analysis.
5.8.4 Identify the basic criteria for a water well design.
5.8.5 Identify the differences in groundwater potential.
5.8.6 Assess the potential for water contamination at a specific site.
5.8.7 Measure volumes of water (e.g., wells, ponds, runoff, waterways).
5.8.8 Control water (e.g., pumps, dams, retention ponds, drainage).
5.8.9 Define, delineate and assess watersheds and streams.

Correlated English Language Arts Academic Content Standards

- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates*. (Measurement D, 8-10)
- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Apply various measurement scales to describe phenomena and solve problems.* (Measurement B, 11-12)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe how Earth is made up of a series of interconnected systems and how a change in one system affects other systems.* (Earth and Space Sciences B, 11-12)
- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)
- *Predict how human choices today will determine the quality and quantity of life on Earth.* (Science and Technology A, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)

5.9 Pollution Control

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	X
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Comply with pollution control measures.

Level 2 Secondary Benchmark:
Evaluate pollution control measures.

Postsecondary Benchmark:
Establish a pollution management and prevention program.

Indicators:

5.9.1 Identify the presence of pollution and pollutants.
5.9.2 Perform an environmental sampling, and chart and analyze the results.
5.9.3 Describe the environmental impact from both industrial and non-industrial processes.
5.9.4 Quantify the extent of pollution.
5.9.5 Locate sources of pollution (e.g., point source and non-point source).
5.9.6 Monitor and conduct remediation activities.
5.9.7 Monitor radioactive contamination.
5.9.8 Monitor noise and light pollution, and implement abatement measures.

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)

- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Describe how human activities can impact the status of natural systems.* (Life Sciences G, 9-10)
- *Explain how human choices today will affect the quality and quantity of life on earth.* (Life Sciences F, 11-12)

5.10 Solid Waste and Renewable Resource Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Collect and dispose of solid waste using the best available technology.

Level 2 Secondary Benchmark:
Control and process solid waste using both available and alternative technologies.

Postsecondary Benchmark:
Create and implement a solid waste and renewable resource management plan for a specific site.

Indicators:

5.10.1 Collect, analyze and treat waste materials (e.g., mortalities, manure, garbage).

5.10.2 Identify the risks associated with solid waste accumulation, utilization and disposal.

5.10.3 Determine an acceptable site for disposing solid waste.

5.10.4 Describe the processes of aerobic and anaerobic waste decomposition (biotic and abiotic influences).

5.10.5 Describe and monitor solid waste disposal procedures (e.g., landfills, lagoons, runoff).

5.10.6 Describe and implement waste management methods (e.g., composting facility, waste incineration, recycling).

5.10.7 Explain the control processes and potential uses for waste byproducts (e.g., landfill gas, sludge, manure, methane).

5.10.8 Describe standard operational techniques, and identify design requirements for specific purposes (e.g., landfill, lagoon, leachate treatment).

5.10.9 Describe site closure methods and post-closure monitoring.

5.10.10 Determine the volume of solid waste generated by an operation or facility.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.* (Measurement E, 8-10)
- *Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.* (Patterns, Functions and Algebra D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

5.11 Potable Water Treatment Operations

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select a potable water treatment method for a specific purpose.

Level 2 Secondary Benchmark:
Monitor the water treatment processes for potable water at a specific site.

Postsecondary Benchmark:
Monitor the processes in water treatment for the community potable water system.

Indicators:

5.11.1 Identify the characteristics of potable water treatment and the sources of water.
5.11.2 Collect potable water samples.
5.11.3 Identify the components of water entering a water treatment facility.
5.11.4 Analyze the components of potable water.
5.11.5 Monitor the processes in water treatment (e.g., aeration, mixing, coagulation, flocculation, filtration and sedimentation processes, water softening, stabilization, corrosion control, disinfection, iron and manganese removal, fluoridation, demineralization).
5.11.6 Monitor the control and treatment of contaminants in water (e.g., trihalomethanes, sulfur, lead, bacteria, algae, nitrates).
5.11.7 Describe taste and odor control in water treatment.
5.11.8 Identify methods for preventing backflow.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Describe sampling methods and analyze the effects of method chosen on how well the resulting sample represents the population.* (Data Analysis and Probability G, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

5.12 Wastewater Treatment Operations

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select a wastewater treatment method for a specific purpose.

Level 2 Secondary Benchmark:
Monitor the wastewater treatment methods for a specific site.

Postsecondary Benchmark:
Monitor community wastewater treatment processes.

Indicators:

5.12.1 Identify the components of a wastewater treatment system.
5.12.2 Collect wastewater samples.
5.12.3 Describe wastewater collection systems.
5.12.4 Identify, analyze and reconcile the components of wastewater with state and local standards.
5.12.5 Troubleshoot wastewater collection systems.
5.12.6 Describe the processes in wastewater treatment (e.g., mixing, coagulation and flocculation; disinfection; treatment system; effluent disposal; solids management).
5.12.7 Analyze process optimization and treatment processes for the treatment train, effluent disposal and biosolids management in wastewater treatment.
5.12.8 Identify methods for cross-connection and backflow prevention.
5.12.9 Identify industrial pretreatment programs.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Describe sampling methods and analyze the effects of method chosen on how well the resulting sample represents the population.* (Data Analysis and Probability G, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

5.13 Hazardous Materials Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	X
Animal Science and Management	X
Biotechnology	X
Food Science and Technology	X
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Differentiate between restricted and non-restricted hazardous materials.

Level 2 Secondary Benchmark:
Follow handling, storage, and recording procedures for hazardous materials.

Postsecondary Benchmark:
Develop and implement a hazardous materials management plan.

Indicators:

5.13.1 Describe health and safety practices for reducing risks from hazardous materials (e.g., MSDS forms, employer notification forms, personal protective equipment).

5.13.2 Demonstrate appropriate responses for major types of hazardous materials disasters (e.g., chemical, fire and explosion, general safety hazards).

5.13.3 Demonstrate an ability to obtain and use information addressing hazardous substance discharge.

5.13.4 Demonstrate safe management, handling, disposal and/or recycling procedures for hazardous and regulated materials and hazardous waste.

5.13.5 Detect and identify hazardous materials.

5.13.6 Perform site evaluation to determine the presence and storage of hazardous materials.

5.13.7 Retrieve and evaluate hazardous materials and hazardous waste sample data.

5.13.8 Prepare hazardous materials for transportation and storage, in accordance with regulations.

5.13.9 Maintain hazardous material handling documentation.

5.13.10 Identify hazardous materials that can be recycled.

Correlated English Language Arts Academic Content Standards

- *Apply reading comprehension strategies to understand grade-appropriate text.* (Reading Process A, 8-10; Reading Process A, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)

5.14 Habitat Management and Restoration

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Monitor an area to determine what characteristics currently exist in a specific habitat.

Level 2 Secondary Benchmark:
Establish goals for remediating a specific habitat.

Postsecondary Benchmark:
Develop and implement a restoration and/or land use plan.

Indicators:

5.14.1 Identify the properties and characteristics of habitats.
5.14.2 Explain wetlands classification (e.g., swamp, marsh, bog, fen).
5.14.3 Explain the functions of wetlands, forests, grasslands and other habitats.
5.14.4 Describe the biotic components of different types of habitats.
5.14.5 Delineate wetlands according to government standards.
5.14.6 Explain the impact of an increasing human population on habitats.
5.14.7 Explain the government's role in habitat restoration and conservation.
5.14.8 Identify techniques used in habitat management, mitigation, enhancement and restoration programs.
5.14.9 Survey and monitor species within a habitat.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.* (Earth and Space Sciences D, 9-10)
- *Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future.* (Earth and Space Sciences C, 11-12)
- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Explain how humans are connected to and impact natural systems.* (Life Sciences B, 11-12)
- *Explain how human choices today will affect the quality and quantity of life on earth.* (Life Sciences F, 11-12)
- *Explain how societal issues and considerations affect the progress of science and technology.* (Scientific Ways of Knowing C, 11-12)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)
- *Use appropriate data sources and geographic tools to analyze and evaluate public policies.* (Geography C, 11-12)
- *Critique data and information to determine the adequacy of support for conclusions.* (Social Studies Skills and Methods B, 11-12)

5.15 Geographic Information Systems (GIS)

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	
Natural Resource Management	X

Level 1 Secondary Benchmark:
Use GIS software to interpret maps.

Level 2 Secondary Benchmark:
Use GIS computer applications to produce maps.

Postsecondary Benchmark:
Use GIS applications to make land use management decisions.

Indicators:

5.15.1 Interpret and evaluate the accuracy of digital imagery and aerial photography.
5.15.2 Explain map projections and the use of scales.
5.15.3 Describe data structures (e.g., vector, grid, TIN).
5.15.4 Explain digital elevation methods (e.g., DEM, GPS).
5.15.5 Interpret spatial interpolation and two- and three-dimensional functional spatial analyses.
5.15.6 Explain ranging methods.
5.15.7 Identify sources of possible errors in GIS and possible corrections and/or solutions.
5.15.8 Determine one's position on the earth.
5.15.9 Develop a GIS plan.
5.15.10 Integrate GPS data into GIS applications.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Social Studies Academic Content Benchmarks

- *Use appropriate data sources and geographic tools to analyze and evaluate public policies.* (Geography C, 11-12)

6. Food Science

Standard Statement:
Learners apply principles of biology, chemistry and physics to the research and development, production, processing, and distribution of food products meeting quality assurance standards in a system that is safe and secure.

6.1 The Science of Food

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Differentiate the structures, functions and sources of basic functional ingredients and the role they play in human nutrition.

Level 2 Secondary Benchmark:
Manipulate temperature, pH and/or water content to determine their effects on functional ingredients.

Postsecondary Benchmark:
Identify the functionality of ingredients in a specific food product, and determine potential substitute ingredients.

Indicators:

6.1.1 Describe the nature of matter in foods (e.g. elements, compounds, mixtures, chemical bonds, classification of matter, physical and chemical changes).

6.1.2 Describe the sources and forms of energy, the relationship between heat and temperature, how heat is transferred, and the factors that affect the rates of reaction in food processing.

6.1.3 Measure the acidity and alkalinity of food products, and describe the role of pH in food processing and storage.

6.1.4 Describe water's function in food processing, distinguish between moisture content and water activity, and demonstrate how water activity affects food functionality and storage.

6.1.5 Describe the composition, structure and sources of sugars, complex carbohydrates, lipids and proteins (functional ingredients) and their nutritional contribution to dietary needs.

6.1.6 Describe the functions and physical properties of simple and complex carbohydrates, lipids and proteins (functional ingredients) in the manufacturing of food products.
6.1.7 Describe the roles of enzymes as catalysts and the factors that effect enzyme activity.
6.1.8 Describe the composition, structure and sources of vitamins and minerals and their nutritional contribution to dietary needs.
6.1.9 Describe the functions and physical properties of vitamins, minerals and phytochemicals in the manufacturing of food products.
6.1.10 Describe the metabolic processes and the factors that effect metabolic changes in the human body (anabolism, catabolism, basal metabolism).
6.1.11 Describe the structure of molds, bacteria, viruses, prions and yeast; how they reproduce; and the factors that affect their growth.
6.1.12 Calculate the nutritional content of food products.
6.1.13 Describe the use of food additives in food products.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Use appropriate self-monitoring strategies for comprehension.* (Reading Process C, 8-10; Reading Process C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.* (Life Sciences B, 9-10)
- *Explain how processes at the cellular level affect the functions and characteristics of an organism.* (Life Sciences A, 11-12)
- *Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.* (Physical Sciences B, 9-10)
- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)
- *Explain how energy may change form or be redistributed but the total quantity of energy is conserved.* (Physical Sciences F, 9-10)

6.2 Quality Assurance

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Examine the food production process, and locate sources or potential sources of food quality deviations.

Level 2 Secondary Benchmark:
Inspect the food production process, locate sources or potential sources of food quality deviations, and prepare a corrective action plan.

Postsecondary Benchmark:
Develop, implement and maintain a quality assurance program.

Indicators:

6.2.1 Identify and describe the types of spoilage microorganisms.
6.2.2 Identify and describe critical quality attributes of food products (e.g., appearance, flavor, texture).
6.2.3 Demonstrate methods for evaluating food quality (e.g., chemical, microbiological, sensory/organoleptic, physical).
6.2.4 Develop a quality check, based on food quality attributes and regulation.
6.2.5 Establish finished product quality attributes.
6.2.6 Develop product specifications.
6.2.7 Evaluate, inspect and select raw food products for manufacturing, based on raw ingredient specifications.

Correlated English Language Arts Academic Content Standards

- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

6.3 Food Production and Processing

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Develop a process flow diagram for a food product.

Level 2 Secondary Benchmark:
Process a food item using basic preparation techniques (e.g., mixing, grinding).

Postsecondary Benchmark:
Process a food item using advanced preparation techniques (e.g., extruding, pumping, canning).

Indicators:

6.3.1 Describe the process used in thermal and non-thermal preservation, control the variables, and apply thermal processing methods (e.g., retorting, high pressure, irradiation, pulse electric field (PEF), aseptic packaging, chilling, freezing).

6.3.2 Describe the process of dehydration and concentration, control the variables that affect the quality of dried foods, and apply the methods.

6.3.3 Describe the functions and types of packaging operations, equipment and materials and use in manufacturing food products (e.g. metal, glass, paper, plastic, film, laminates, edible coatings).

6.3.4 Compare and contrast reduced oxygen packaging (ROP) and processes, and use them in the manufacturing of food products (e.g. controlled atmosphere and modified atmosphere packaging, desiccants).

6.3.5 Describe key food processing operations (e.g., mixing, grinding, pumping, washing).

6.3.6 Describe storage and distribution methods for non-shelf-stable products.

6.3.7 Identify the characteristics and properties of mixtures (solutions, colloidal dispersions and suspensions), and select appropriate chemical or biological separation techniques.

6.3.8 Describe the initial processing of animals and animal products and the basis for product grading.

6.3.9 Differentiate among beneficial microorganisms (e.g., bacterial, mold and yeast) and their uses in food production.

6.3.10 Process food products through biological processing (e.g. fermenting, enzymes, microbes).

6.3.11 Manage processes for handling solid and liquid waste resulting from the manufacturing of food products.
6.3.12 Describe and select biological, chemical and mechanical processing procedures for manufacturing food products.
6.3.13 Process food products through mechanical processing (e.g., cut, grind, heat, homogenize, texturize, extrude, mill, mix).
6.3.14 Process food products through chemical processing (e.g. hydrating, hydrogenating and tenderizing).
6.3.15 Identify the energy resources utilized in processing a food product.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Apply mathematical knowledge and skills routinely in other content areas and practical situations.* (Mathematical Processes B, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.* (Life Sciences B, 9-10)
- *Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.* (Physical Sciences C, 9-10)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

6.4 Food Product Development

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Modify an existing food product using bench-top methods, and develop a package design.

Level 2 Secondary Benchmark:
Create a new food prototype using limited ingredients and processing steps, and develop a package design.

Postsecondary Benchmark:
Create a new food prototype (including processing methods and package design) to meet a specific dietary need or demand, and seek label approval.

Indicators:

6.4.1 Conduct a sensory evaluation of food and food analogs.
6.4.2 Identify motivations for producing new products.
6.4.3 Manipulate ingredients to reach a desired product goal.
6.4.4 Calculate nutrient values and serving sizes in a food product.
6.4.5 Estimate the variability in nutritional content.
6.4.6 Calculate the parts per million of restricted ingredients.
6.4.7 Develop a food product label according to industry standards.
6.4.8 Estimate the shelf life and potential changes in attributes over time.
6.4.9 Develop a product and raw materials gold standard.
6.4.10 Find new uses for low value components of the food generation process.

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Solve increasingly complex non-routine measurement problems and check for reasonableness of results.* (Measurement A, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

6.5 Food Safety and Security

Program Area	
Agribusiness and Production Systems	
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	X
Horticulture	
Natural Resource Management	

Level 1 Secondary Benchmark:
Identify and assess food safety risks for an enterprise.

Level 2 Secondary Benchmark:
Develop a food safety and security plan, addressing facility needs and contamination points.

Postsecondary Benchmark:
Develop a risk management plan that complies with food safety regulations and with emergency management protocol.

Indicators:

6.5.1 Control and monitor the eight major food product allergens.
6.5.2 Establish and implement procedures for preoperational inspection and cleaning (e.g., Sanitation Standard Operating Procedures [SSOPs], visual, ATP swabs, sanitation swabs, nonpathenogenic tests).
6.5.3 Identify the sources and types of food-borne illness and food-borne pathogens (e.g., salmonella, E. coli 0157:H7, listeria) and how they enter the food supply.
6.5.4 Prevent and/or control food-borne illness through environmental monitoring.
6.5.5 Develop and implement a pest control system.
6.5.6 Conduct a good manufacturing practices (GMP) audit, review the findings and implement corrective actions.
6.5.7 Identify hazards and critical control points.
6.5.8 Scientifically establish critical limits, monitor control points and apply corrective action procedures (HAACP).
6.5.9 Identify the methods used to assess food security.
6.5.10 Determine critical safety parameters for handling and storage (e.g., cold chain, temperature control, sanitation, cleanliness).
6.5.11 Conduct a product hazard analysis and an ingredient hazard analysis.
6.5.12 Identify the key activities of a traceback/recall program.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Explain the ways in which the processes of technological design respond to the needs of society.* (Science and Technology A, 9-10)

7. Plant Science

Standard Statement:
Learners apply principles of plant anatomy, physiology, nutrition and genetics to the research and development, selection and reproduction, planting, fertilization, health, harvesting, and management of plants in a domestic and/or natural environment.

7.1 Plant Nutrition

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select and apply macronutrients, using basic application methods, and recognize the effects on plants and on the environment.

Level 2 Secondary Benchmark:
Diagnose macronutrient and common micronutrient deficiencies in specific plants, and select and apply macronutrients and micronutrients, using specialized application methods.

Postsecondary Benchmark:
Customize a fertilization program and apply customized fertilizers.

Indicators:

7.1.1 Compare and contrast organic and inorganic sources of macronutrients and micronutrients.
7.1.2 Describe the functions of macronutrients and micronutrients.
7.1.3 Determine nutrient requirements for food-grade, non-food-grade and organic plants.
7.1.4 Identify symptoms and causes of plant nutrient deficiencies.
7.1.5 Collect and test soil and/or plant tissue.
7.1.6 Analyze test data from soil and plant tissue, make inferences, and draw conclusions for optimum management.
7.1.7 Determine the biotic and abiotic factors that influence and optimize the availability of nutrients to plants (e.g., pH, microorganisms, growth media).

7.1.8 Calculate nutrient requirements, and select nutrient sources and additives for optimum economic return.

7.1.9 Select application methods, determine the time of application, and apply nutrients.

7.1.10 Interpret fertilizer labels.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing).* (Reading Process B, 8-10; Reading Process B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations*. (Scientific Inquiry A, 9-10)

7.2 Plant Reproduction

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Select and apply basic methods for propagating common types of plants.

Level 2 Secondary Benchmark:
Select and apply specialized methods for propagating plants.

Postsecondary Benchmark:
Select and propagate plants for specific genetic characteristics and economic variables.

Indicators:

7.2.1 Identify the reproductive anatomy of plants, and describe their physiological functions.

7.2.2 Determine the biotic and abiotic factors that influence and optimize plant reproduction (e.g., insects, light, temperature, microorganisms, moisture, location).

7.2.3 Select seeds and seed stock for desired traits (e.g., color, drought resistance, chemical resistance, environmental impact).

7.2.4 Select and use methods that create desired traits in seeds and fruits (e.g., detasseling, mechanical pollination).

7.2.5 Select and use methods of asexual plant propagation for desired traits (e.g., grafting, layering, cuttings, cloning).

7.2.6 Compare and contrast variations of plant reproductive systems among plant species and their adaptive and non-adaptive values.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)

Correlated Science Academic Content Benchmarks

- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Describe the ethical practices and guidelines in which science operates.* (Scientific Ways of Knowing C, 9-10)
- *Explain how societal issues and considerations affect the progress of science and technology.* (Scientific Ways of Knowing C, 11-12)

7.3 Pest Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Identify common types of plant pests, and apply basic pest management and control methods.

Level 2 Secondary Benchmark:
Scout and identify specific plant pests and plant damage, and apply specialized pest management and control methods.

Postsecondary Benchmark:
Evaluate and design an integrated pest management program.

Indicators:

7.3.1 Identify and classify plant pests (i.e., insects, pathogens, weeds, diseases, animals).

7.3.2 Examine the interrelationships among plants, pests, humans and the environment (e.g., non-native species, climate change).

7.3.3 Analyze and calculate the economic threshold of pest damage.

7.3.4 Determine and implement pest management safety practices (e.g., MSDS, EPA, OSHA, PPE).

7.3.5 Develop an integrated pest management plans, based on pest life cycles, available treatments and application methods.

7.3.6 Select application methods, implement a pest control plan (i.e., organic and non-organic), and evaluate its effectiveness and its impact on the environment.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

- *Compile, organize and evaluate information, take notes and summarize findings.* (Research B, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Find, use and interpret measures of center and spread, such as mean and quartiles, and use those measures to compare and draw conclusions about sets of data.* (Data Analysis and Probability D, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the structure and function of ecosystems and relate how ecosystems change over time.* (Life Sciences F, 9-10)
- *Explain how humans are connected to and impact natural systems.* (Life Sciences B, 11-12)
- *Predict how human choices today will determine the quality and quantity of life on Earth.* (Science and Technology A, 11-12)
- *Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.* (Scientific Inquiry A, 9-10)

Correlated Social Studies Academic Content Benchmarks

- *Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment.* (Geography B, 11-12)

7.4 Plant Production and Management

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Manage the growth of common types of plants.

Level 2 Secondary Benchmark:
Manage the growth of specific types of plants using specialized equipment.

Postsecondary Benchmark:
Develop and evaluate a commercial plant production and management plan.

Indicators:

7.4.1 Identify and classify seeds and plants at all their stages of growth.
7.4.2 Identify plant anatomical structures and tissues (e.g., roots, stems, flowers, leaves, fruits, seeds).
7.4.3 Describe the physiological functions of plants (e.g., photosynthesis, respiration, transpiration, absorption).
7.4.4 Identify and classify plants using taxonomy.
7.4.5 Select seeds and plants (e.g., production, ornamental, erosion control, genetically modified organisms [GMO], moisture control, bioremediation).
7.4.6 Manipulate abiotic and biotic factors (e.g., irrigation, mulch, lighting, temperature, drainage) to alter plant germination, growth and development.
7.4.7 Evaluate and demonstrate planting practices (e.g., population rate, germination, seed vigor, inoculation, seed and plant treatments, cuttings and pot in pot, type of planter).
7.4.8 Evaluate and implement transplanting practices.
7.4.9 Select, evaluate and prepare soil or media for planting.
7.4.10 Control plant growth (e.g., pruning, pinching, chemical, disbudding).
7.4.11 Determine a maintenance schedule for the plant management plan.
7.4.12 Analyze and satisfy plant water requirements.
7.4.13 Identify characteristics (e.g., visual appeal, quality, test weights, final usage) of grains, seeds, vegetables, fruits and ornamental plants.

Correlated English Language Arts Academic Content Standards

- *Use multiple resources to enhance comprehension of vocabulary.* (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
- *Apply knowledge of roots, affixes and phrases to aid understanding of content area vocabulary.* (Acquisition of Vocabulary D, 11-12)
- *Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly.* (Writing Applications C, 11-12)

Correlated Mathematics Academic Content Benchmarks

- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.* (Data Analysis and Probability A, 11-12)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)
- *Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.* (Mathematical Processes H, 8-10)

Correlated Science Academic Content Benchmarks

- *Explain the flow of energy and the cycling of matter through biological and ecological systems (cellular, organismal and ecological).* (Life Sciences D, 9-10)
- *Summarize the historical development of scientific theories and ideas within the study of life sciences.* (Life Sciences G, 11-12)
- *Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations*. (Scientific Inquiry A, 9-10)
- *Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.* (Scientific Inquiry A, 11-12)

7.5 Harvesting, Handling and Storage

Program Area	
Agribusiness and Production Systems	X
Agriculture and Industrial Power Technology	
Animal Science and Management	
Biotechnology	
Food Science and Technology	
Horticulture	X
Natural Resource Management	X

Level 1 Secondary Benchmark:
Harvest, handle and store plants and plant products.

Level 2 Secondary Benchmark:
Identify and minimize harvest loss, and select preferred harvesting, handling and storage methods.

Postsecondary Benchmark:
Develop and evaluate systems for plant harvesting, handling and storage.

Indicators:

7.5.1 Determine crop maturity.
7.5.2 Identify safe harvesting, handling and storage practices.
7.5.3 Determine and control environmental conditions relative to harvesting, handling and storage.
7.5.4 Demonstrate harvesting, handling and storage techniques to minimize loss and to maximize economic return.
7.5.5 Calculate yield and loss of harvesting, processing and storage.
7.5.6 Maintain and/or enhance the quality of plant products in harvesting, handling and storage (e.g., temperature, humidity, retardants, light, chemicals, contamination).
7.5.7 Prepare products for sale, transportation and storage.

Correlated Mathematics Academic Content Benchmarks

- *Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.* (Number, Number Sense and Operations G, 8-10)
- *Construct convincing arguments based on analysis of data and interpretation of graphs.* (Data Analysis and Probability F, 8-10)
- *Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.* (Data Analysis and Probability C, 11-12)