# Agricultural and Environmental Systems Career Field

## Bio Energy

**Subject Code: 010716**

**Outcome & Competency Descriptions**

**Course Description:**

Students will be introduced to the scientific and technical processes of biofuel/bioenergy production. Learners will evaluate the energy conversion process and methods for optimizing the fermentation process. Students will identify the systems and components employed by fermentation systems and communicate safe handling techniques of biomass, effluent and biogas. Throughout the course, students will evaluate environmental impacts, life-cycle analysis, and economic analysis of bioenergy production.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome: 1.1. Employability Skills**

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.

**Outcome: 1.3. Business Ethics and Law**

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work environment.

1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

1.3.6. Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales,

deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.

1.3.8. Verify compliance with computer and intellectual property laws and regulations.

**Outcome: 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).

1.4.4. Use system hardware to support software applications.

1.4.6. Use an electronic database to access and create business and technical information.

**Outcome: 1.6. Business Literacy**

Develop foundational skills and knowledge in entrepreneurship, financial literacy and business operations.

**Competencies**

1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the

organizational departments and interdepartmental interactions.

1.6.6. Identify the target market served by the organization, the niche that the organization fills and an outlook of the industry.

1.6.7. Identify the effect of supply and demand on products and services.

1.6.8. Identify the features and benefits that make an organization’s product or service competitive.

**Outcome: 1.10. Sales and Marketing**

Manage pricing, place, promotion, packaging, positioning and public relations to improve quality customer service.

**Competencies**

1.10.2. Determine the customer's needs and identify solutions.

1.10.3. Communicate features, benefits and warranties of a product or service to the customer.

1.10.4. Identify the company policies and procedures for initiating product and service improvements.

1.10.5. Monitor customer expectations and determine product/service satisfaction by using measurement tools.

1.10.6. Discuss the importance of correct pricing to support a product’s or service’s positioning in the

marketing mix.

1.10.7. Describe the importance and diversity of distribution channels (i.e., direct, indirect) to sell a product.

**Outcome: 1.11. Principles of Business Economics**

Examine and employ economic principles, concepts and policies to accomplish organizational goals and objectives.

**Competencies**

1.11.1. Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services).

1.11.2. Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior.

1.11.4. Determine how the quality, quantity and pricing of goods and services are affected by domestic and international competition in a market economy.

**Outcome: 1.12. Site and Personal Safety Procedures**

Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation and take corrective action.

**Competencies**

1.12.1. Use Occupational Safety and Health Administration (OSHA) defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.

1.12.2. Interpret safety signs and symbols.

1.12.4. Describe how working under the influence of drugs and alcohol increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.

1.12.5. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

1.12.6. Identify procedures for the handling, storage and disposal of hazardous materials.

1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.

1.12.8. Identify safety hazards and take corrective measures.

1.12.9. Identify, inspect and use safety equipment appropriate for the task.

1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.

1.12.14. Identify the source of electrical hazards and use shutdown and established lock-out/tag-out

procedures.

**Strand 3. Biotechnology**

Learners engage in the scientific process, learn fundamental processes using modern tools and laboratory techniques, adhere to safety protocols, and bring a biotechnology product to the market.

**Outcome: 3.1. Research and Experiments**

Use scientific methodology to conduct problem-based studies, develop products, and interpret results.

**Competencies**

3.1.1. Design a research plan, including the significance of the problem, purpose, hypotheses, objectives, appropriate controls, independent variables, dependent variables, methods of study and a list of materials.

3.1.2. Examine sources for credibility.

3.1.3. Apply sampling methods that appropriately represent the population and implement procedures for systematic data collection.

3.1.4. Explain the importance and design of trialing, and the information gained from it.

3.1.5. Document results of the experiment in a laboratory notebook, including a statement of purpose, experimental design, observations, results, conclusions and next steps.

3.8.7. Document results of the experiment in a laboratory notebook, including a statement of purpose, experimental designs, observations, results, conclusions, and next steps.

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

3.1.8. Define the concepts of confidence intervals and significant figures.

3.1.9. Use t-test and p-value to determine statistical significance of results.

3.8.11. Draw conclusions based on observations and data analyses, recognizing that experimental results must be open to the scrutiny of others.

3.1.12. Prepare and present findings using scientific reports

**Outcome: 3.3. Specimen, Equipment, and chemical handling**

Handle, prepare, transport, store and dispose of specimens and chemicals. Monitor, record and maintain the integrity of equipment and instrumentation, environmental conditions of the facility and the inventory.

**Competencies**

3.3.1. Prepare and interpret labels for chemicals, supplies and equipment.

3.3.2. Use chemical references to identify hazards associated with handling and storing chemicals.

3.3.3 Safely transfer chemicals from storage containers to equipment used in the laboratory.

3.3.4. Neutralize acids, bases or caustic solutions for handling and disposal.

3.3.5. Sample, monitor and record the environmental conditions of the facility (e.g., air quality, temperature, microbial contaminations).

3.3.6. Identify and describe the purpose of common laboratory equipment.

3.3.7. Select personal protective equipment for various laboratory protocols.

**Outcome: 3.4. Applying Chemistry to Laboratory Practices**

Using common laboratory equipment, apply general and organic chemistry concepts to examine the structures, functions, binding of molecules, and methodologies for their purity and characterization.

**Competencies**

3.4.2. Use the periodic table to describe atomic structure and to characterize molecules based on functional groups.

3.4.3. Differentiate between organic and inorganic compounds.

3.4.4. Use common and chemical nomenclature for organic and inorganic materials.

3.4.7. Describe chemical bonding and bond types and the relationships that they have with the physical state of materials.

3.4.8. Apply the concepts of stoichiometry and the laws of thermodynamics to chemical reactions.

3.4.9. Balance chemical reactions.

3.4.10. Identify materials that can be used as a catalyst and describe their role in reactions.

3.4.13. Calculate errors in various measurements, based on data acquired using common laboratory equipment.

3.4.14. Apply standard rules for determining the number of significant figures in measurements and in the answers to corresponding calculations.

3.4.15. Convert units of measure from English to metric, within the English system, and within the metric system.

3.4.16. Calculate the volume, temperature and pressure of gases using the ideal gas law, Charles' Law and Boyle's Law.

**Strand 6. Environmental Science**

Learners apply earth, life, and physical sciences to the production, extraction, processing, protection, use, and renewal of both renewable and non-renewable resources.

**Outcome: 6.8. Contaminants and Pollution Control**

Assess an affected area, determine the source and type of contaminant and respond.

**Competencies**

6.8.2. Determine the types, sources and impact of natural and man-made contaminants.

6.8.3. Monitor, analyze and quantify levels of contaminants from point and non-point sources.

6.8.5. Describe the environmental impact from both industrial and nonindustrial processes.

6.8.10. Identify and describe requirements to develop and implement various emergency response plans.

**Outcome: 6.9. Hazardous Materials and Waste Management**

Follow and apply handling, storage and recording procedures for hazardous materials and waste.

**Competencies**

6.9.2. Describe health and safety practices for reducing risks from hazardous materials (e.g., safety data sheet [SDS], employer notification forms, personal protective equipment [PPE]).

6.9.3. Demonstrate appropriate responses for major types of hazardous materials disasters.

6.9.5. Demonstrate safe management, handling, disposal and recycling procedures for hazardous materials and waste.

6.9.6. Perform site assessments to detect and identify the presence and storage of hazardous materials.

**Strand 8. Plant Science**

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.

**Outcome: 8.5. Harvesting**

Describe and implement harvesting methods.

**Competencies**

8.5.1. Determine crop readiness for salability and environmental conditions that can impact crop quality at harvest.

**Outcome: 8.6. Handling and Storage**

Handle and store plants and plant products to maximize quality and longevity

**Competencies**

8.6.2. Explain, monitor, and manipulate conditions for optimal handling and storage of plants and plant products.

8.6.3. Calculate potential yield and loss due to processing and storage.

8.6.4. Prepare products for sale, transportation and storage.

8.6.5. Identify storage methods and storage capacity for plants and plant products.

8.6.6. Explain the reasons for preparing plants and plant products for distribution.

8.6.7. Implement and evaluate techniques for grading, handling, blending, segregating, packaging and loading plants and plant products for distribution or transportation.

**Strand 9. Energy**

Learners apply principles of physics, chemistry, the earth sciences and mathematics to energy sources, transformations, acquisition, applications and their impacts.

**Outcome: 9.1. Energy Sources**

Identify energy sources according to their economic viability, sustainability, and environmental impact.

**Competencies**

9.1.2. Identify, compare and contrast renewable energy sources and the technology used to generate energy.

9.1.3. Identify, compare, and contrast renewable energy sources and the technology used to generate energy.

9.1.4. Identify the social, economic and environmental drivers and barriers that influence the development and use of energy sources.

9.1.5. Identify and describe energy density properties of different types of fuel sources according to industry standards.

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

9.1.7. Identify and describe best management practices (e.g., carbon sequestration, conservation, animal safety, efficiency) that lessen environmental impact.

**Outcome: 9.3. Biomass**

Describe and manage processes required to extract energy from biomass.

**Competencies**

9.3.1. Identify applications for biomass energy production.

9.3.2. Describe the thermal, chemical and biochemical methods of converting biomass into energy.

9.3.3. Identify feedstock materials used to produce biofuels and compare the energy potential of each material.

9.3.4. Identify and differentiate the aerobic and anaerobic digestion of biomass.

9.3.5. Test source materials and final products and compare the results to industry standards.

9.3.6. Process source materials for energy conversion.

9.3.7. Identify and describe technical standards and governance for placing agricultural, commercial, and industrial biofuel operations.

9.3.8. Identify the byproducts generated in the production of biofuels and apply methods for their extraction, use and disposal.

9.3.9. Identify and describe storage and distribution systems for biofuels.