U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA)

Promote sustainable Agriculture Concepts in Education through multidisciplinary Research and Pedagogical Trainings (PACE)

Texas A&M University-Kingsville

Summer 2025 Program

Cohort #1: June 9 to June 26, 2025 Cohort #2: July 1 to July 18, 2025

Project #1: Fundamental Understanding of Tearing and Fracture Behavior of Food Packaging Films

Faculty Advisor: Dr. Mohammad Motaher Hossain, Mechanical and Industrial Engineering

***i. Motivation*:** Polymeric films have been extensively used in packaging industries with applications include packaging film for frozen products, shrink film for transport packaging, food wrap film, packaging bags, fill and seal packaging film, and so on. Retaining structural integrity of food packaging films is a major concern for preservation of food quality and safety. A scratch on food packaging film can cause it to tear prematurely or compromise its barrier properties, which may ruin the product inside. Thus, significant research efforts are currently undergoing to study various fracture modes of food packaging films. However, difficulty in characterizing various fracture process zones *in-situ* hinders fundamental understanding of fracture behavior of polymer films. Fundamental understanding of tearing and fracture behavior will enable improving the toughness of food packaging films, extending the shelf-life and improving the food safety.

***ii. Project Description*:** The study will primarily focus on linear low-density polyethylene (LLDPE), which is one of the most widely used material for food packaging films. Various tearing and fracture modes of LLDPE films with variation in film thickness will be studied, using: i) ASTM standard scratch testing, using an in-house scratch machine; ii) Double-edge-notched tension (DENT) testing following the Essential Work of Fracture (EWF) method using an in-house universal testing machine (MTS Criterion Model 45); and iii) ASTM standard mode III out-of-plane tearing test, using the MTS universal testing machine. The photoelastic imaging technique will be used to understand the fracture process zones *in-situ* for the DENT EWF and tearing tests. Optical microscopy (OM) will be performed to investigate the fracture mechanisms.

***iii. Research Training for the Participants*:** Two teachers in each cohort will work together in this project. They will work together to conduct scratch, DENT EWF, and tearing tests on polymer films. They will also work together to conduct *in-situ* photoelastic observation and OM to study different failure modes. Different cohorts will choose different variation of LLDPE (e.g., processing variation, such as blow-up ratio (BUR), draw down ratio (DDR), etc.) and other polymer films (e.g., polypropylene (PP), polystyrene (PS) and polyamide (PA) films).

Project #2: Basics of Soil and Water Conservation for Agriculture and Ecosystems
Faculty Advisor: Dr. Benjamin Turner, Agriculture and Natural Resource Management

***i. Motivation*:** Excessive sediment concentrations resulting from landscape scale erosion processes can adversely affect water quality and fish habitat and lead to environmental determination of surface water sources being impaired or threatened. The objectives of this project are to: 1) Build a demonstration instrument and teaching/extension protocol for rainfall-erosion simulation in the field or lab, and 2) Construct curriculum material for student and instructor use.

***ii. Project Description*:** Erosion and runoff are physical processes that must be managed like other agroecosystem processes. The erosion process is initiated by one of two forces: wind or water impact. Wind erosion can begin with light wind that rolls soil particles along the surface (surface creep) through to a strong wind that lifts and detaches large volume of soil particles (saltation) into the air to create dust storms (suspension). On the other hand, water erosion is initiated by the kinetic energy of rain drops to the soil surface, which if unimpeded, detaches and splashes soil particles making them available to be carried downslope in overland flow, rills, or eventually gullies. A rain droplet's kinetic energy is one-half of its mass times velocity squared. A soil's susceptibility to or risk of detachment during rainfall events can be evaluated by its "erosivity". The project aims to build an erosion demonstration and related curriculum material around agricultural and conservation efforts used to minimize risks of soil erosion.

***iii. Research Training for the Participants*:** Participants will learn about the trade-offs scientists must make in designing research laboratories and experiments, and considerations for communicating research results to non-scientific audiences. Participants will also triangulate and link research processes and insights and extension communication plans (resulting from objective 1) with existing STEM learning outcomes they currently teach for in these classrooms. Appropriate reading material, supplemental videos, and instructor resources will then be tailored to those outcomes.

Project #3: Life Cycle Assessment for Agricultural Products
Faculty Advisor: Dr. Hua Li, Mechanical and Industrial Engineering

***i. Motivation*:** Life Cycle Assessment (LCA), as a modern analytical tool, has been increasingly applied to different types of products, processes, and systems to help assess their environmental impacts. LCA has become a central element through governments all over the globe. Based on the concept of life cycle, it comprehensively summarizes the impacts of agriculture on the environment, which is an effective tool to promote the sustainability and green development of agriculture.

***ii. Project Description*:** This project will investigate the environmental impacts of selected agricultural products or biomass based on the data availability. OpenLCA will be used as the software to conduct the life cycle assessment for the selected products. The major tasks include: 1) understanding the fundamental concepts of LCA and Circular Economy, 2) learning to use OpenLCA software, which is free to the public, 3) selecting products based on the data availability, 4) Analyzing and comparing the environmental impacts of selected products using OpenLCA.

***iii. Research Training for the Participants*:** Two teachers will work together on this project. Both teachers will learn the fundamental concepts and OpenLCA software. Each teacher will analyze at least one selected product and compare the results with each other.

Project #4: Developing Decision Making Support Systems for Sustainable Agriculture Product Supply Chain

Faculty Advisor: Dr. Kai Jin, Mechanical and Industrial Engineering

***i. Motivation*:** Improving supply chain efficiency and sustainability has been a challenge in the decision making process, especially to agriculture products which have unique features compared to other products. The usage of modern high-tech communication tools generated huge amount of data and information that can be used in the decision making process. However, there is lack of a systematic platform that can help the user visualize and effectively use the data.

***ii. Project Description*:** Engineering economic analysis methods and tools are part of the approaches to process the available big data on agriculture and generate valuable information to assist the decision making process. Discounted costs and benefits over a fixed period of time will be compared. The ratio of total benefits to total cost (benefit-cost ratio) or equivalently, the total net benefits (net present value) will also be evaluated. Furthermore, goal seeking and sensitivity analysis will be used to address the uncertainty in the problems. The steps to be used in this project to estimate the economic consequences of a decision can be summarized as: a) Define the problem and the objective; b) Identify feasible alternatives for accomplishing the objective, taking into account any constraints; c) Select a method or methods of economic analysis; d) Select a technique that accounts for uncertainty and/or risk; e) Compile data and make assumptions called for by the economic analysis method(s) and risk analysis technique; f) Compute a measure of economic performance; and, g) Compare the economic consequences of alternatives and make a decision, taking into account any non-quantified effects and the risk attitude of the decision maker.

***iii. Research Training for the Participants*:** Two teachers will work together on the literature survey and data search. The teachers will then define their own research problem and objective within the scope to improve agriculture product supply chain efficiency and sustainability. Both teachers will be trained with different economic analysis methods and tools. Each teacher will implement different methods and tools on the data obtained from USDA websites, and will evaluate their effectiveness and efficiencies on agriculture applications.