1. Quantifying Above- and Below-ground Biomass in Willow & Switchgrass Crops

Faculty: Dr. Jamie Schuler

Project Site: Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV.

Project: Quantifying above- and belowground biomass in willow & switchgrass crops

Brief Description: Willow and switchgrass biomass crops are being grown on marginal agricultural and formerly reclaimed mine sites for use in bioproducts and bioenergy. The development of accurate biomass estimates across different soil types is key for investors and understanding carbon life cycles associated with these crops. In order to provide better estimates of the sequestration potential of these crops, additional data on above- and below-ground biomass. This project will utilize various techniques to estimate biomass. The student will also participate in crop establishment and maintenance practices throughout the summer session.

Background Required: Background in forestry, agriculture, natural resources, and/or remote sensing and an interest and desire to work outdoors as well as in a lab setting.

Additional Details:

- All students are expected to participate in person at WVU in Morgantown, WV for the duration of the program (May 22 – July 28, 2023)
- The stipend for this summer research opportunity is $6,000.
- The program will include field trips to biomass/bioproducts/bioenergy partners and facilities in the region. Transportation will be provided for these activities.
- Housing is available for the 10-week period in the dorm at WVU or off-campus apartments (https://housing.wvu.edu/housing-options/residence-halls/seneca-hall, or https://campuslife.wvu.edu/student-advocacy/off-campus-housing/off-campus-housing-publications, https://www.thedaonline.com/wvuliving/).

Application:

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2. Monitoring Soil Greenhouse Gas Emission

Faculty: Dr. Amir Hass

Project Site: West Virginia University, Morgantown, WV; or West Virginia State University Agricultural & Environmental Research Station (AERS), Institute, WV.

Project: Monitoring Soil Greenhouse Gas Emission

Brief Description: Soils are recognized for their important role in nutrient cycling, and especially in that of carbon and nitrogen; the elemental source for several potent greenhouse gases (GHG; e.g. N_2O, CO_2, CH_4). The net impact of soil as a sink or a source of GHG depends on soil composition and environmental conditions such as prevailing moisture and redox condition, nutrient content and availability, stability composition and source of organic matter, decomposers composition and function, etc.; all which are highly management-dependent. As such, it is important to identify and quantify the interrelations and linkages between specific soil and land management practices and their net impact on soil environment conditions and GHG emission, and carbon sequestration. The specific objective of this project is for the student to engage and assist in the design assembling and operation of a stand-alone off-the-grid soil GHG monitoring system and in its field deployment and testing. Once fully operated, the system will be deployed to a specific field trial for long-term monitoring to determine selected management practices' impact on soil GHG emissions.

Expected Outcomes: The outcome of this project will benefit the MASBio project as it will help elucidate and quantify the role and impact of selected land management practices and use of bio-based products as soil amendment (e.g. biochar) on soil carbon sequestration and GHG emission. The project will provide experiential learning to staff and students in operating state-of-the-art GHG monitoring system and technology.

Background Required: Preference will be given to an enthusiastic highly engaged undergraduate student pursuing environmental engineering, biology, and/or any soil/natural resources management degree pathway and career.

Additional Details:

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3. Biochar for Soil Amendment and Carbon Sequestration

Faculty: Dr. Charlene Kelly, Dr. Shawn Grushecky, Dr. Jingxin Wang

Project Site: Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV.

Project: Biochar for soil amendment and carbon sequestration

Brief Description:

Biochar is biomass that has been transformed into a charred material that is intended to be added to soil to improve nutrient- and water-holding capacity and sorb potential plant toxins such as heavy metals, thus improving plant productivity on degraded landscapes. Additionally, the carbon in biochar material is stable against degradation, allowing for increased carbon storage below ground. Biochar can be used as an amendment in many different land uses, including mine reclamation, marginal agricultural lands, urban areas, and streamside revegetation efforts. This project will assess the stability and fate of the carbon and its potential for storage in soil amended with biochar, as well as its capacity to improve plant productivity, particularly root development. Results from this work will be shared in publications and conferences.

The outcome of this work will be helpful to the MASBio project because biochar is a value-added product of waste biomass material from harvest operations and processing mills. Biochar can help to reduce the carbon footprint of forest harvest and other operations.

Background Required: Educational background in forestry, soil science, or environmental science as well as an interest and desire to work in both field and lab settings. Some understanding of soil science and experience with field sampling and lab analysis are a plus.

Additional Details:

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4. 3D Printing of Biomass-based Bioproducts

Faculty: Dr. Levente Denes

Project Site: Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV.

Project: 3D printing of Biomass-based Bioproducts

Brief Description:

Additive manufacturing technology (AM) or 3D printing is one of the most advanced technologies capable to produce complex-shaped prototypes and functional parts or even full products using the layer-by-layer deposition principle. Several AM technologies, like Fused Deposition Modeling, and Binder Jetting can process the woody biomass also, making it possible to expand the utilization area of forest resources. More and more articles are published about the 3D printing of natural fibers, however, there are still many questions unanswered. Between them, we find the compatibility of the wood fibers with the matrix materials, and the optimization of the 3D printing technology taking into consideration the specific characteristics of natural fibers, recycling the printed objects at the end of life-cycle, and scaling the technology to a structural level. This research will explore the utilization of bio-based materials for 3D printing, will analyze the relationship between bio-filament characteristics and printing quality, and optimize the printing technology based on previous findings.

The outcome of this work will be helpful to the MASBio project because extends the utilization of biomass using advanced technologies, develops new value-added products, and reduces the carbon footprint during the process of biomass valorization.

Background Required: Educational background in forest products, wood science, engineering, or chemical engineering as well as an interest and desire to work in a lab setting. Some understanding of pd printing with physical testing of wood products is a plus.

Additional Details:

- All students are expected to participate in person at WVU in Morgantown, WV for the duration of the program (May 22 – July 28, 2023)
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5. Sustainable Low-carbon Intensity Building Materials

Faculty: Dr. Levente Denes, Dr. Jingxin Wang

Project Site: Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV.

Project: Sustainable Low-carbon Intensity Building Materials

Brief Description:

Developing carbon-negative structural building materials is crucial to meeting global decarbonization goals because they are used in extremely large quantities and their demand rate will continue to grow with the population increase and with the increasingly stringent environmental regulations. Mass timber Products, like Cross-Laminated Timber (CLT), are green and sustainable materials since are made of renewable wood, have high carbon storage capacities, and can be processed with high energy efficiency. By converting the underutilized low-grade hardwood lumber into construction materials, the life span and consequently the carbon storage capacity will multiply immediately. The newly developed hardwood CLTs can significantly reduce the negative environmental impact of transportation when the construction sites are in the Appalachian Region and the nearby urbanized areas. The project addresses the main technical research areas that are needed to develop HCLTs such as machine stress rating of hardwood lumber, gluing of laminates, development of hardwood CLT products, and testing the physical-mechanical properties of the CLT products.

The outcome of this work will be helpful to the MASBio project because extends the utilization of hardwood biomass using advanced technologies, convert low-grade sawmill products into value-added sustainable materials, and develops new paths to reduce the carbon footprint of biomass products.

Background Required: Educational background in forest products, wood science, engineering, or chemical engineering as well as an interest and desire to work in a lab setting. Some understanding of wood processing with physical testing of wood products is a plus.

Additional Details:

- All students are expected to participate in person at WVU in Morgantown, WV for the duration of the program (May 22 – July 28, 2023)
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6. Value-added Bioproducts from Biomass

Faculty: Dr. John Hu

Project Site: Department of Chemical and Biomedical Engineering, West Virginia University, Morgantown, WV.

Project: Value-added Bioproducts from Biomass

Brief Description: Biomass consists of three major chemical components: cellulose, hemicellulose, and lignin. In recent years, cellulose and hemicellulose were mainly saccharified into C5 and C6 sugars, which are widely used in refining industries for cosmetic and pharmaceutical products. The sugar extraction process has created many lignin wastes. In addition, traditionally, the pulping industry extracted pulp from woody biomass and left all lignin as waste, which is typically burned as fuel to supplement the energy cost in pulp mills. Thus, lignin wastes from both sources were heavily underutilized. Value-added bioproducts made from these lignin wastes were strongly desired. In Dr. Hu's lab at West Virginia University (WVU), these lignin wastes were converted to the small size of oligomers as well as phenolic monomers using facile and relatively affordable catalytic depolymerization processes. The resultant lignin oligomers and monomers are great feedstock for adhesive formation. These lignin-derived chemicals were used to synthesize wood adhesives and tested for mechanical performance.

The outcome of this work will be helpful to the MASBio project because the innovation in lignin utilization advances the technology for manufacturing bio-based products and reduces the carbon footprint during the process of biomass valorization.

Background Required: Educational background in forest products, biochemistry, or chemical engineering as well as an interest and desire to work in a lab setting. Some understanding of wood chemistry and experience with physical testing of wood products is a plus.

Additional Details:

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7. Life Cycle Assessment of Biomass for Biochar System

Faculty: Dr. Jingxin Wang

Project Site: Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV (https://www.davis.wvu.edu/faculty-staff/directory/jingxin-wang)

Project: Life Cycle Assessment of Biomass for Biochar System

Brief Description: The student intern will be involved in research related to environmental life cycle assessment of the conversion of biomass resources into value-added biochar. Sustainable biomass can be used as a feedstock for the production of bioproducts for carbon sequestration. Life cycle assessment (LCA) is a science-based, comparative analysis and assessment of the environmental impacts of product systems. The student will develop system thinking skills, apply the ISO framework to perform the life cycle analysis, learn how to analyze and summarize the data, and contribute to the production of reports.

The outcomes of this work will be helpful to the MASBio project as the project will help in communicating the environmental benefits associated with biobased products made from renewable biomass materials.

Background Required: The ideal candidate for this position will:

- Be a senior or junior undergraduate student studying forestry, wood science, forest biomaterials, biosystems, sustainable energy, or a related major;
- Have a basic understanding of the system approach and life cycle assessment;
- Have good work ethics;
- Have a strong commitment to working with diverse individuals and communities.

Additional Details:

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