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SCIENCE ON A MISSION TO CUT EMISSIONS

If you don't think emissions from fossil fuels are harmful to Earth, you must be living on Mars.

The use of these fuels raises the average temperature of the planet, pollutes the air when they are burned and may cause environmental damage as part of the mining process. The **need for alternatives to fossil fuels has never been greater**, which makes the timing perfect for the project "Biomass Feedstock for Food and Energy Security in the North: Solutions to Technical Issues, Economic Feasibility and Environmental Sustainability".

"We have been involved with research on biomass processing and utilization for energy and bioproducts for more than a decade now," said **Dr. Lope Tabil**, a professor in the Department of Chemical and Biological Engineering at the **University of Saskatchewan**. Dr. Tabil is the lead on this project along with **Dr. Edmund Mupondwa**, research scientist with **Agriculture and Agri-Food Food Canada (AAFC)** at the Saskatoon Research and Development Centre. Dr. Mupondwa is also an adjunct professor in the Department of Chemical and Biological Engineering at the University of Saskatchewan.
The two other project co-applicants are **Dr. Duncan Cree**, assistant professor in the Department of Mechanical Engineering, **University of Saskatchewan** and **Dr. Tim Dumonceaux**, research scientist with **AAFC**.

"A number of processing options for biomass have to be researched because they are not well understood," said Dr. Tabil. "In 2012, BioFuelNet was formed, of which I was one of the researchers. In 2018, we continued our research on biomass processing for energy and bioproducts with the current project activity under Biomass Cluster."

This project came about as a response to emerging issues related to the use of nonrenewable feedstocks, such as petroleum.

Cuttings pile at NorSask Forest Products Inc. in Meadow Lake, SK owned by partner industry supporter Meadow Lake Tribal Council
Picture supplied by Dr. Lope Tabil

Fueling innovation

"As is well known, fossil fuels like petroleum, coal and natural gas provide a majority of our daily energy requirements; however, these fossil sources are also widely associated with emissions that have **harmful effects on humans and the environment**," said Dr. Mupondwa. "For example, burning these fossil fuels generates emissions of greenhouse gases (carbon dioxide, methane and nitrous oxide) and other gases into the atmosphere. These emissions not only pollute the air that we breathe, but also **contribute to climate change**."

In response, the current study is part of a new national strategy to develop renewable sources of energy and bioproducts that can **contribute to sustainable development.** In this regard, biomass sources (such as wheat straw and other crop and forestry residues) provide sustainable alternatives to fossil fuels. Not only can they be utilized to produce bioenergy and other bio-based products, but their production is renewable through sustainable agriculture and forestry.

"Canada has great potential to supply agricultural and forestry biomass, but the use of biomass has not yet evolved to a commercial scale due to technical and logistical challenges associated with the utilization of biomass in its unprocessed form," said Dr. Mupondwa.

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In that form, this type of biomass has low energy density, which represents a key obstacle in its exploitation as an energy source. Furthermore, the chemical structure of the biomass requires capital intensive processes to extract valuable sugars that can be used to produce bioenergy, biofuels, biomaterials and biochemicals. As a result, this project came about to provide solutions to these problems and enable commercial utilization of biomass feedstocks for the bioeconomy.

Camelina straw pellets produced with or without ultrasonic pretreatment. Picture supplied by Dr. Lope Tabil

When the growing gets tough…

Those feedstocks are of particular interest to agricultural growers in **Canada's northern latitudes**, where the growing season is limited. This activity aims to support those growers by extending their growing season through the supply of biomass feedstock for heat and power generation.

"Examples of the biomass we are studying include agricultural crop residues such as oat hull, wheat, barley and oat straw, along with purpose-grown crops such as **camelina** and **switchgrass** and **forest residues**," said Dr. Tabil. "As well, we are developing processes for pretreatment of biomass such as torrefaction and steam explosion, and pelletizing of these materials that have been pretreated."

Sterilized switchgrass and camelina straw for microbial pretreatment. Picture supplied by Dr. Lope Tabil

Torrefaction of biomass is a mild form of decomposition at temperatures typically between 200 - 320 °C. Torrefaction changes biomass properties to **provide a better fuel quality** for combustion and gasification applications.

At the end of the day, researchers hope that the results from their technoeconomic analysis and life cycle assessment contribute to a critical goal: resolving persistent challenges in designing business models for large-scale commercial use of rich sources of biomass available in Canada for the development of the bioeconomy.

"In particular, our results have near-term implications with respect to our goal of supporting agricultural growers in Canadian northern latitudes to **extend their growing season**" said Dr. Mupondwa.

For his part, Dr. Tabil is intrigued by the possibility that biomass-to-energy projects may have economic and environmental justification. **Until we can colonize Mars, protecting the Earth's environment must be a top priority.**

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For more information on this project, please contact:

Dr. Lope Tabil
Ph: 306-966-5317
Email: lope.tabil@usask.ca

Dr. Edmund Mupondwa
Ph: 306-385-9360
Email: Edmund.mupondwa@canada.ca

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