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Interest High in Low Cost Sorghum Biomass

If you offered farmers a low cost, high production crop, they may respond with a simple question: "What's the catch?"

It might sound like fantasy, but there is real potential to grow sorghum for biomass production and make it profitable, as envisioned by the project "**Develop a Low-Cost and High Production System for Sorghum Biomass on Marginal Lands**".

"Sore gum"?

For the non-farmer and non-scientist, this project sparks another key query: "**What the heck is sorghum**?" Though it is largely an unknown grain in North America, sorghum is considered one of the **most important cereal crops** in the world, due largely to its drought resistance and versatility. While Africa and parts of Asia grow it mainly for human consumption, sorghum is used primarily for livestock feed and ethanol production in Canada and the United States.

"Sorghum can produce **high amounts of biomass** and also has wider adaptability to different growth conditions," said Dr. Lining Tian, research scientist with Agriculture and Agri-Food Canada (AAFC) at the London Research and Development Centre in London, Ontario. Dr. Tian is the lead investigator on this project.

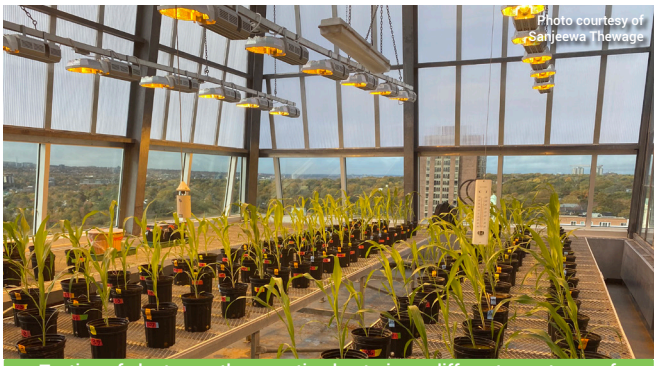
"Canada has a large area of marginal lands, so developing methods of growing sorghum for high biomass production on those lands is **beneficial** to both the **agriculture and biomass industries**," said Dr. Tian.

The impetus for this project actually stems from a collaboration between Dr. Tian and Agriculture Environmental Renewal Canada (AERC), a Canadian plant breeding company specializing in sorghum.

Getting testy

"AERC and Dr. Tian were working towards testing some new cultivars that were genetic types of sorghum, a crop that looks like corn but does not create big ears," said Dr. Kevin Vessey, Professor, Department of Biology at Saint Mary's University in Halifax, Nova Scotia, and co-principal investigator for the project.

Seeded sorghum in Nappan, Nova Scotia.



Testing of plant-growth promoting bacteria on different genotypes of sorghum under greenhouse conditions in Halifax, Nova Scotia.

"In North America, we take the entire sorghum plant, put it in large, wrapped plastic tubes and let it ferment, creating **excellent forage** for cattle," said Dr. Vessey.

As well, AERC uses specific breeding techniques to create sorghum lines that are **high in sugar**. For growers, the benefit of a high sugar crop is that it produces large amounts of biomass that can be used as feedstock for bioethanol. Employed primarily as a fuel substitute for vehicles, bioethanol has advantages over conventional fuel as it comes from a **renewable resource** and produces **fewer greenhouse gas emissions**.

"AERC is an expert at producing these high sugar lines of sorghum," said Dr. Vessey. "They wanted to see if they could take distantly related sorghum lines and cross them to **breed a hybrid** that produces high yields and grows well on relatively poor quality land."

Does growing sorghum make (dollars and) sense?

At present, sorghum crops are fertilized in a similar manner to corn, but this makes little financial sense when growing sorghum for biomass, where the returns are much lower than for food crops. To make such efforts viable, growers must keep production costs low by using **little or no fertilizer** and growing the crop on **marginal land.**

"Though you don't get the same price per tonne with sorghum as for corn or soybeans, the low cost of production is where your economic rationale comes in," said Dr. Vessey. "AERC had a couple of hybrid sorghum lines that they wanted tested for their performance in marginal soil, so they ran yield trials with Dr. Tian at two sites in Ontario: **Simcoe** and **Ottawa**."

The trials tested these hybrids and compared the growth with and without the application of **nitrogen (N) fertilizer.**

Getting their nitrogen fix

"Nitrogen is a crucial nutrient for crops for biomass production," said Dr. Julia Lu, Professor, Department of Chemistry and Biology at Ryerson University in Toronto, and co-principal investigator on the project. "This project is employing biological nitrogen fixing bacteria to **reduce** or **eliminate nitrogen fertilizer usage**.

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My role is to study nitrogen species in soil, and the information generated can be used to evaluate and identify sorghum hybrid(s), as well as evaluating the performance of the bacteria, as the function of these bacteria can be affected by the nitrogen in soil."

Helping to make the growth of sorghum biomass crops **financially viable** is also a priority for Dr. Vessey.

"A lot of my past work has focused on using beneficial microbes, bacteria and fungi to stimulate the growth of various crops, including biomass crops," said Dr. Vessey. "These microbes can be **inexpensive inputs compared to N fertilizer**, and they help the plants access nutrients from the soil for fixing N."

The microbes take N gas out of the air and, through a unique biochemical process, convert it into a form of N that the plants can use.

"The economics say you can't put N fertilizer on biomass plants," said Dr. Vessey. "Instead, maybe we can **inoculate the seed** with these bacteria or fungi when we put it in the ground so it can draw in the nutrients it needs."

To test this hypothesis, Dr. Vessey and his colleagues grew the hybrid lines from AERC in a greenhouse, treating seeds with bacteria and raising them with and without N fertilizer to compare the growth. Though they expect to see less growth where fertilizer is absent, they are hoping that the plants deprived of N **perform better** than ones just grown in soil, and do well enough to be **economically feasible** for growers.

"We have now carried out two rounds of greenhouse studies with five different types of microbes, four bacterial lines and one fungal line," said Dr. Vessey. "While the results thus far are mixed, we have **seen some evidence** of increases in growth from our bacteria."

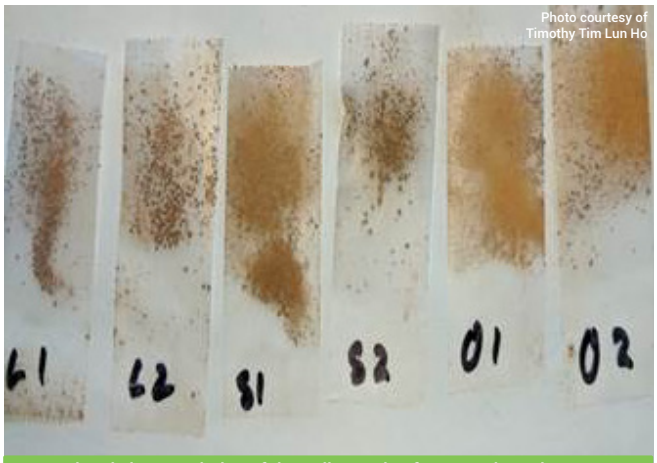
Playing the field

This past summer in Nova Scotia, researchers conducted some field trials under strict protocols. Using two hybrid lines and a control, they tested the plants with three bacteria and one fungal line. That data is currently being analyzed, with **early results suggesting one of the bacteria lines may be stimulating growth of a hybrid line**. Based on the results, they intend to repeat the experiment this summer using the most promising bacteria to verify the results.

It may sound like a lot of testing, re-testing and verifying, but it's all necessary given the realities of crop research.

"The lines we saw doing well in the greenhouse were not the same bacteria that did well in the field," said Dr. Vessey. "That is not uncommon, as the greenhouse offers an ideal environment for plants where they are treated well and watered every day. People often achieve positive results from a bacterial inoculant line under a controlled environment, only to see poorer performance outside where growth conditions are less than ideal: limited water, varying temperatures and much more competition in the soil from bacteria and fungi."

Even so, researchers are encouraged to see potential in one bacteria line for stimulating hybrid sorghum growth in field trials, and they hope to **pass on that potential** to growers.



Visual characteristics of the soil samples from London, Simcoe and Ottawa experimental fields

"We are always looking for different kinds of biomass crops that work in a variety of environments to provide basic feedstocks for a range of users," said Dr. Vessey. "One thing about the sorghum plant is that it's an annual, where you seed it in spring, let it grow in summer and harvest it in the fall. Other crops that I work on are perennials, which tie up the land for 15-30 years. That works fine for some farmers, but **others want more flexibility,** so if they can make a lot of **biomass from marginal land that is only tied up for one year**, that is attractive to certain cropping systems."

If this project is successful, it will be one of the few instances where a large amount of biomass is produced economically, with few inputs, on marginal land, and from an annual crop.

With all of that going for it, rather than inquiring about the catch, growers may ask themselves a different question in regard to sorghum biomass: "**What have I got to lose?**"

Roots of sorghum plants grown with (left) and without (right) a plant-growth promoting bacterium under greenhouse conditions in Halifax, Nova Scotia.

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