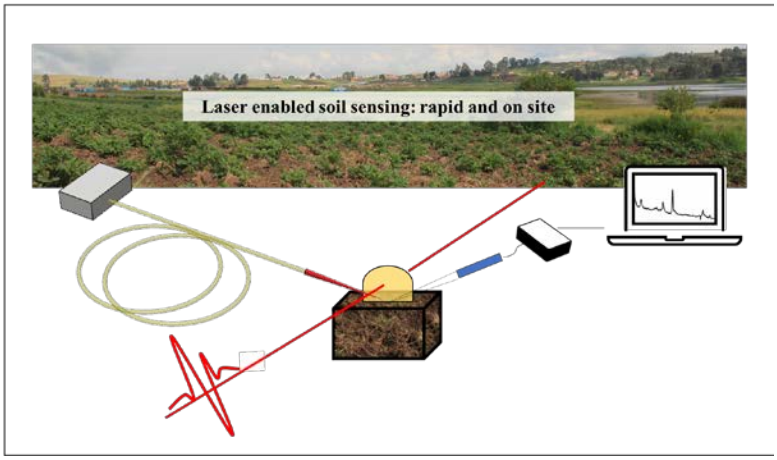
ALBERTA INNOVATES

Clean Resources

Smart Agriculture and Food

Laser-induced breakdown spectroscopy for in-situ soil analysis

Soil testing has become an integral tool for many farmers, who rely on data about soil health to make decisions about fertilizer use and to increase the productivity of their farm. However, detailed soil analysis typically takes place in labs, which requires farmers to collect samples, send them for testing and then wait for the results. The goal of this project is to develop a portable Laser-Induced Breakdown Spectroscopy (LIBS) device for in-situ, high-sensitivity analysis of agricultural soil. It also aims to create an open-source database of soils in Alberta along with a calibration suite using artificial intelligence to provide quick, reliable soil analysis in the field. Ultimately, the portable LIBS-based soil sensor will enable farmers to obtain data about their soil without the time and expense of lab-based analysis.



FUNDING DETAILS

RECIPIENT:
University of Alberta
PI: Dr. Amina Hussein

PARTNERS:
University of Regina
CropPro Consulting
Enersoft
Boreal Laser

TOTAL BUDGET:
$928,000

AI FUNDING:
$498,000

PROJECT DATES:
March 2021 – December 2023

PROJECT TRL:
Start: 2
End: 6

APPLICATION

Agricultural soil sampling is a billion-dollar industry, and the development of a scalable soil sensor is a global challenge. While soil sampling is an active area of growth, there are currently no commercially available systems addressing scalability to large fields. Once calibrated, a LIBS-based sensor could provide information on the fine-scale depth distribution of soil elemental composition, texture and moisture in seconds, with the potential to significantly increase crop productivity for end-users.

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PROJECT GOALS

- Develop a LIBS device for in-field soil analysis and produce a database of soil characteristics.
- Use artificial intelligence techniques to establish algorithms for fast and reliable identification of soils.
- Achieve an optimized LIBS system to develop a portable device for in-field measurements.
- Validate soil measurements through comparison with known soil samples and demonstrate the potential of a LIBS device as a scalable soil sensor to be coupled with mechanical devices for in-field monitoring.

BENEFITS TO ALBERTA

- Reductions in the cost and labour associated with conventional soil sampling techniques for farmers and end-users.
- Improvements in farming approaches for efficient nutrient management to maintain high crop yields.
- Partnerships between academia and industry for technology transfer and economic diversification, as well as creating employment positions for trainees with skills in laser technologies, advanced data science and hardware development.
- Commercial uses of laser-based spectroscopic techniques with far-ranging applications in the detection and characterization of soil contaminants, water sampling, carbon sequestration and agricultural measurements.

6 Publications

22 Students Trained

2 Patents

1 New Product/Service

1 Project Jobs

4-8 Future Jobs

CURRENT STATUS

November 2021

The research team has developed and optimized a lab-based LIBS system for analyzing agriculture soils with different elemental conditions, benchmarking spectroscopic analysis with wet-lab analysis. We have developed sample holders that minimize signal variability and a software-hardware interface for automating data collection. Artificial Intelligence techniques are being applied to spectroscopic soil emissions and compared with conventional analysis techniques, and a database of soil emissions is being curated. Our team is designing a portable system meeting the form-factor required by end-users, including development of an auto-focusing system for laser pulses and identification of components.