

LIBS: A Breakthrough in Soil Analysis and Precision Agriculture

ABSTRACT

The analyses of the soil nutrients content such as phosphorus, calcium, aluminum and magnesium have been done by a standard method called "Mehlich 3" which is time consuming and requires an expensive sample preparation. To date, there are few direct or rapid techniques to quantify the nutrients concentrations of agricultural soils. Meanwhile, precision agriculture is changing many of the traditional soil analyses practices.

Laser Induced Breakdown Spectroscopy (LIBS) technique which is fast and accurate could be the technology for soil analysis that the agriculture deserves. LIBS measurements coupled to chemometric methods provide the quantification of nutrient concentrations as well as the determination of the pH value and the content of organic matter in soils. The National Research Council Canada and Logiag have built a dedicated high throughput LIBS analyzer for agricultural needs that gives soil results performances comparable to the standard technique.

PROBLEMATICS

Optimizing the fertilizing needs requires necessity to analyze soil frequently



- To adjust the quantity need of fertilizing.
- To improve the production and to reduce the cost of production.
- To evaluate and respect the environment criteria.



Standard laboratory method Mehlich 3 needs:

- Drying + grinding.
- Dissolution (acid digestion).
- Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) or Atomic Absorption (AA) analysis.

LOGIAG INNOVATIVE SOLUTION

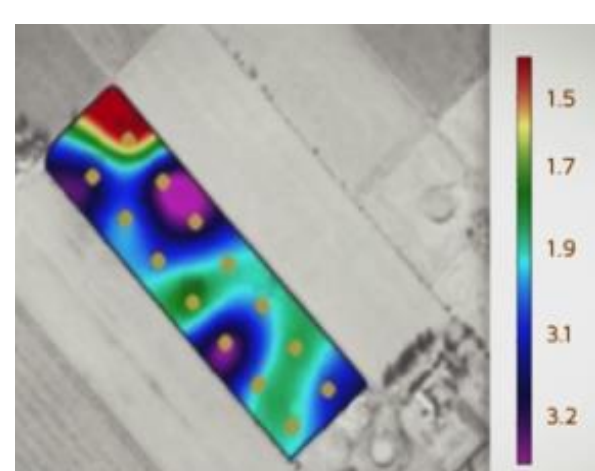
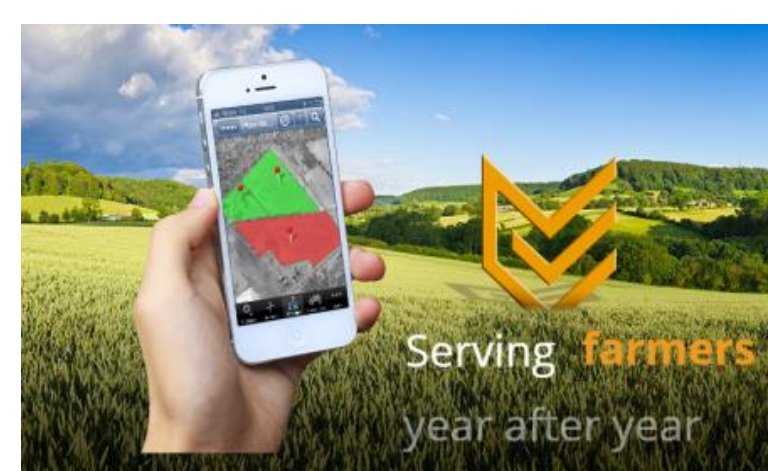
1. Laser induced breakdown spectroscopy

- Fast analysis of samples.
- Few sample preparations.
- Low measurement costs.



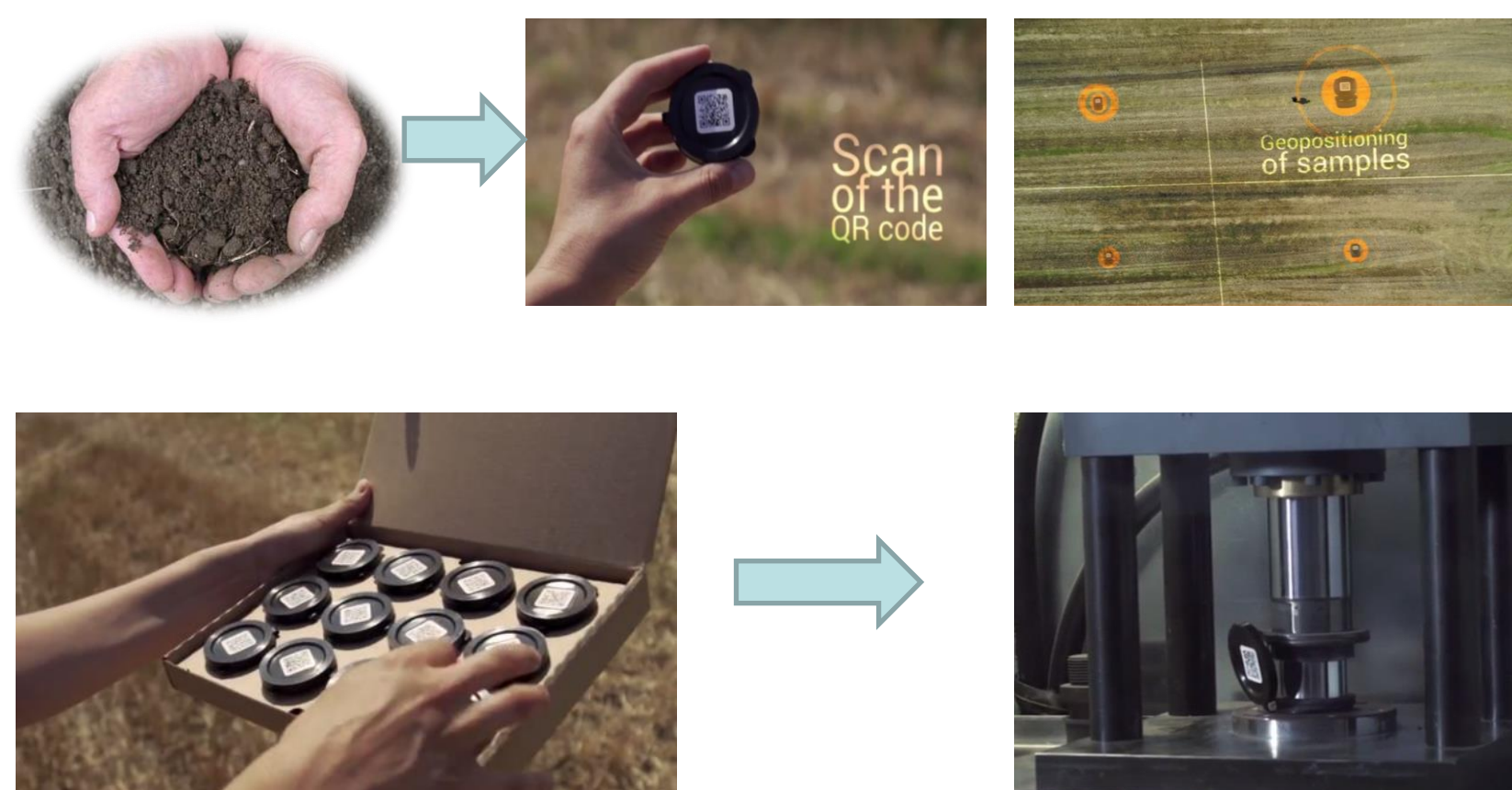
&

2. GPS localization / smartphone application



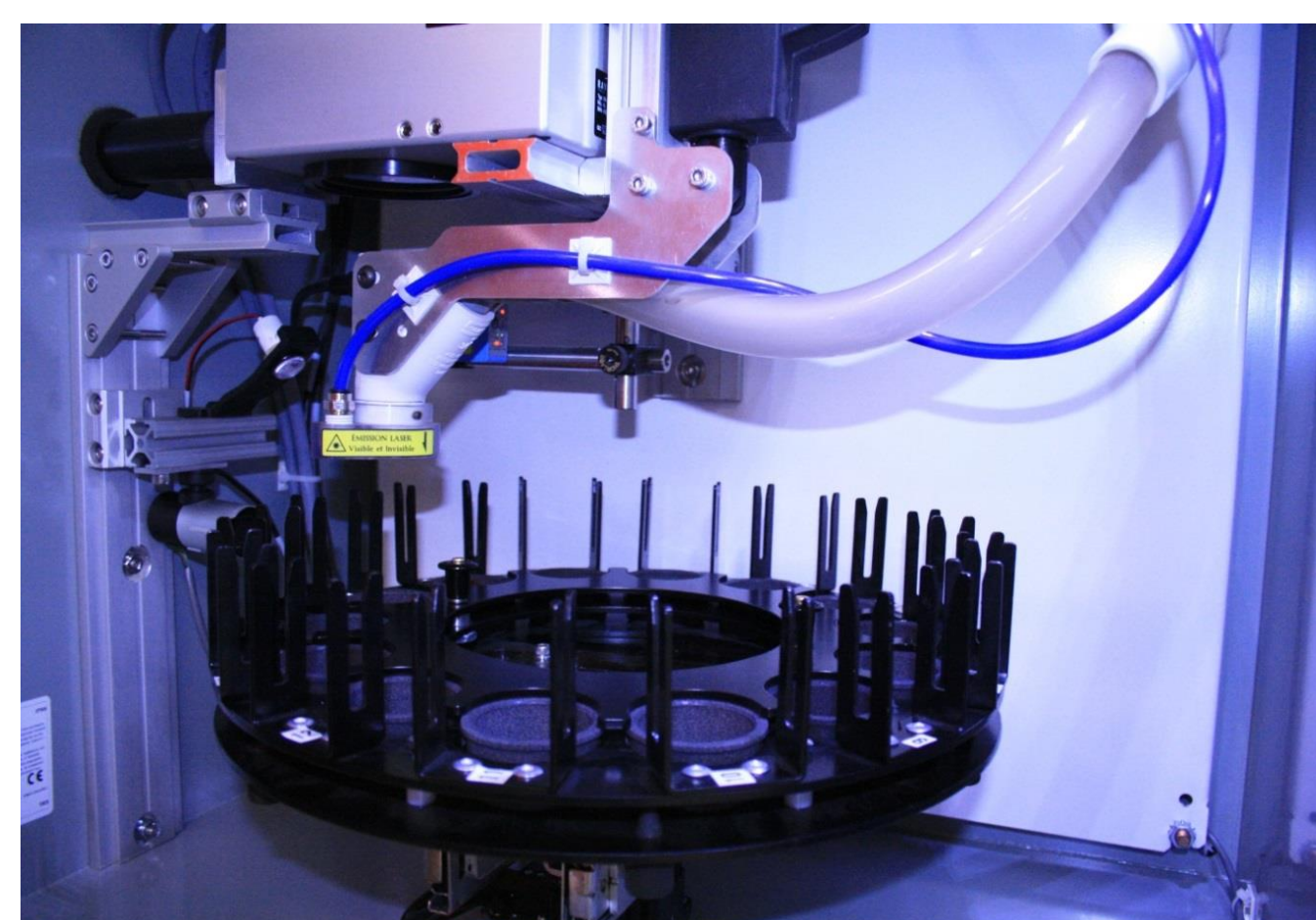
- Recording of the geographical position of sampling
- Spatial distribution maps of the soil's fertility or lime rate.

SAMPLE PREPARATION



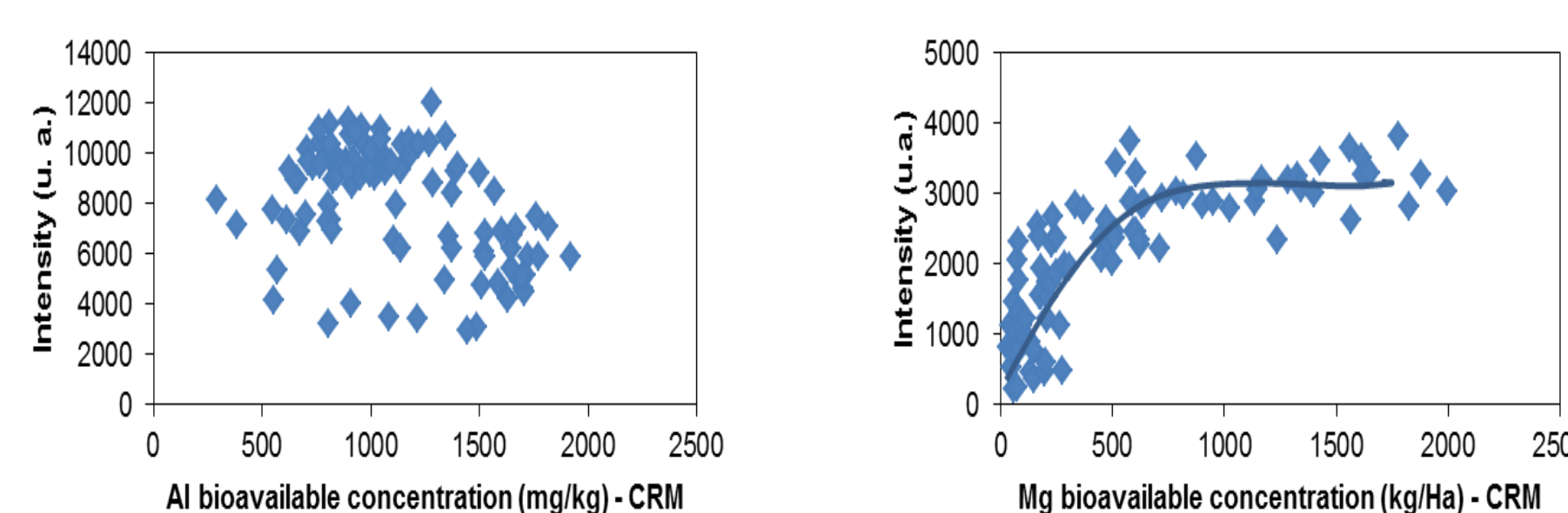
The laboratory sample preparation time is less than 3 minutes.

LIBS SOIL ANALYSIS PROTOTYPE



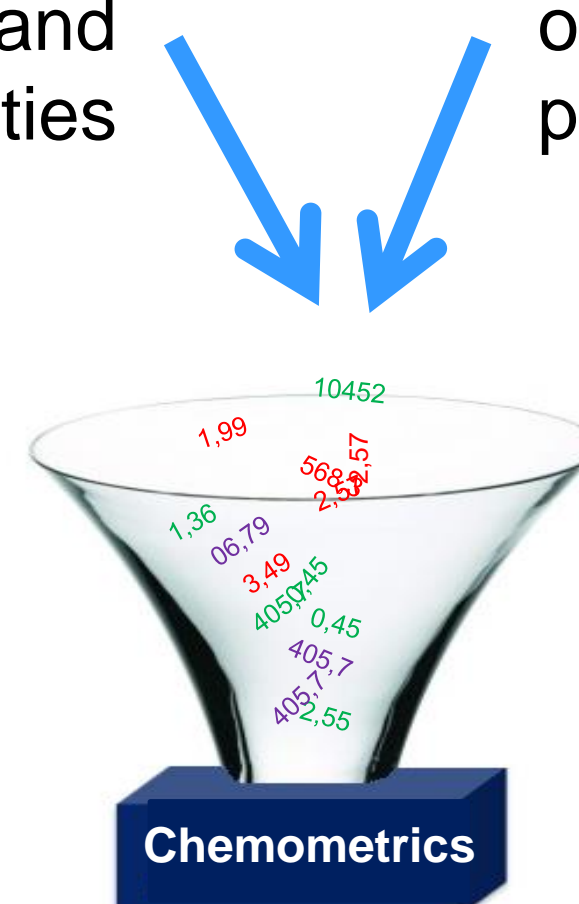
- 2000 acquisitions/sample.
- The measurement time for 12 samples is 6 minutes: 30 seconds/sample.

NECESSITY OF CHEMOMETRIC ANALYSIS



The LIBS signal depends on the total concentration of the analyte element and the physical and chemical proprieties of the plasma

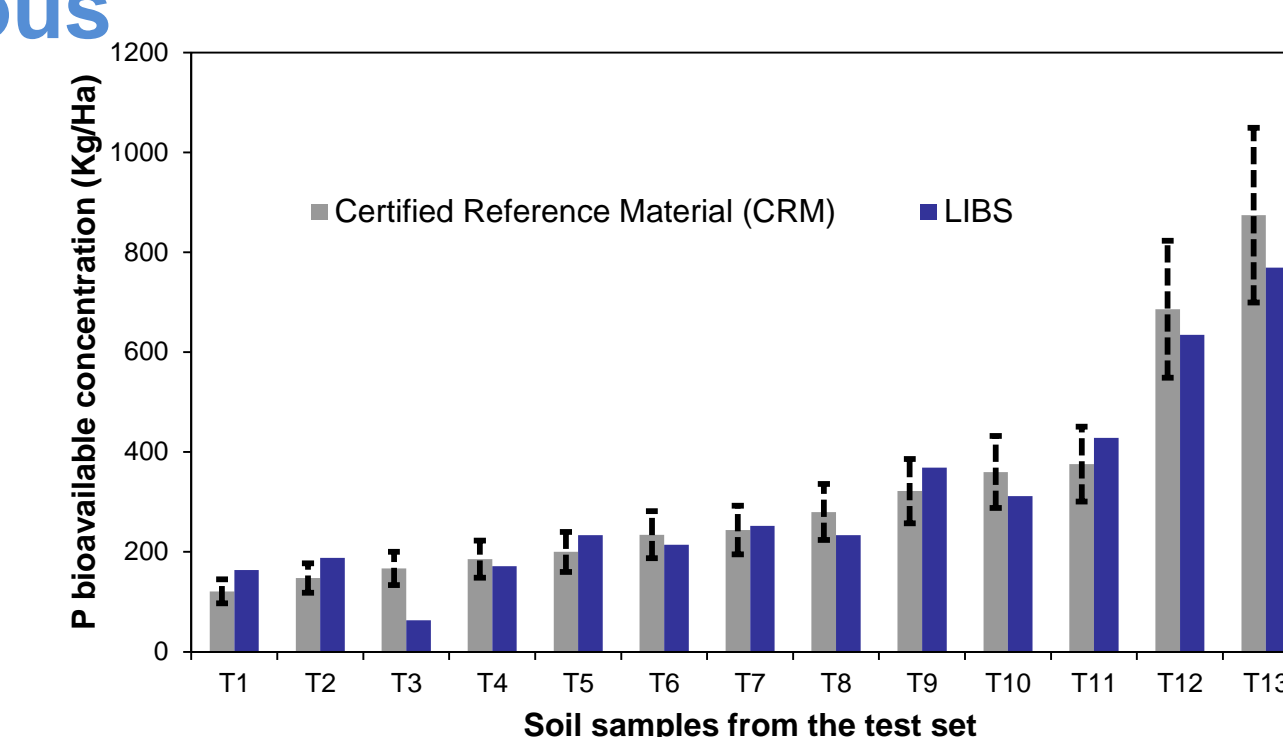
The bioavailability of element depends on soil, matrices (calcareous, silicate, organic matter,...), pH, ...



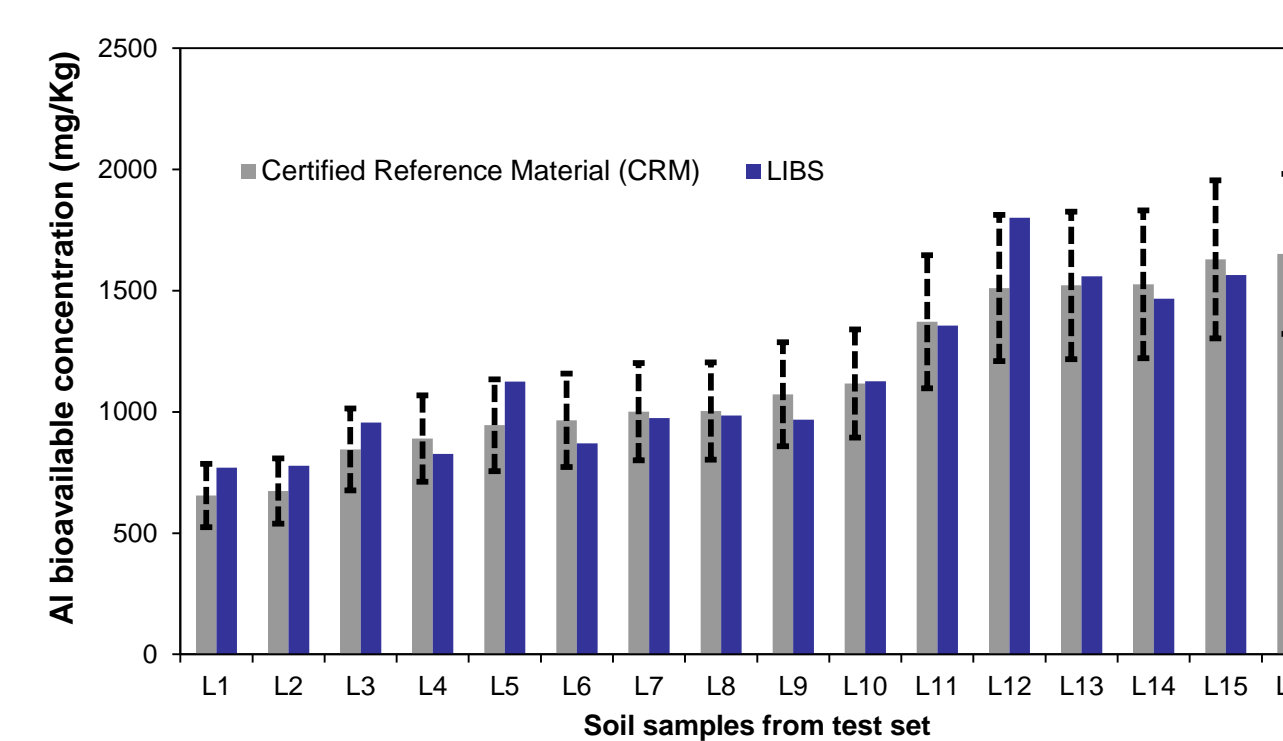
- Global data observation
- Sample classification
- Outlier samples detection
- Quantitative analysis

RESULTS

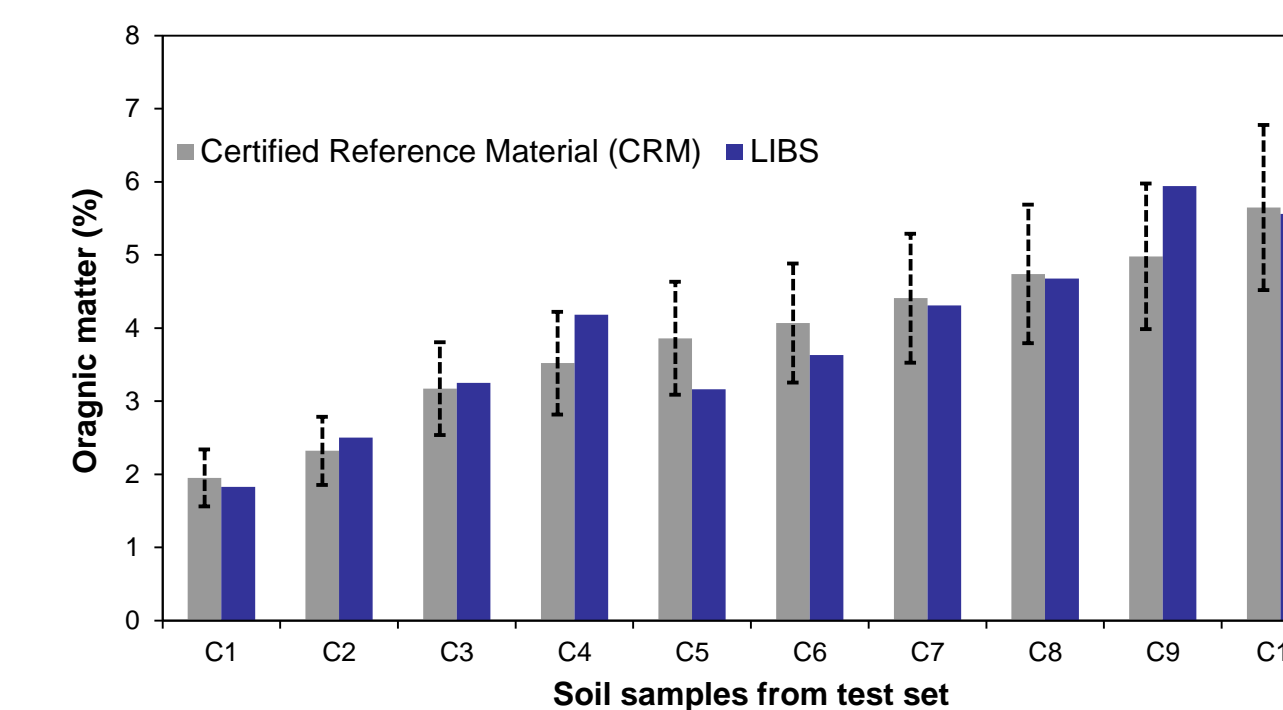
Phosphorous



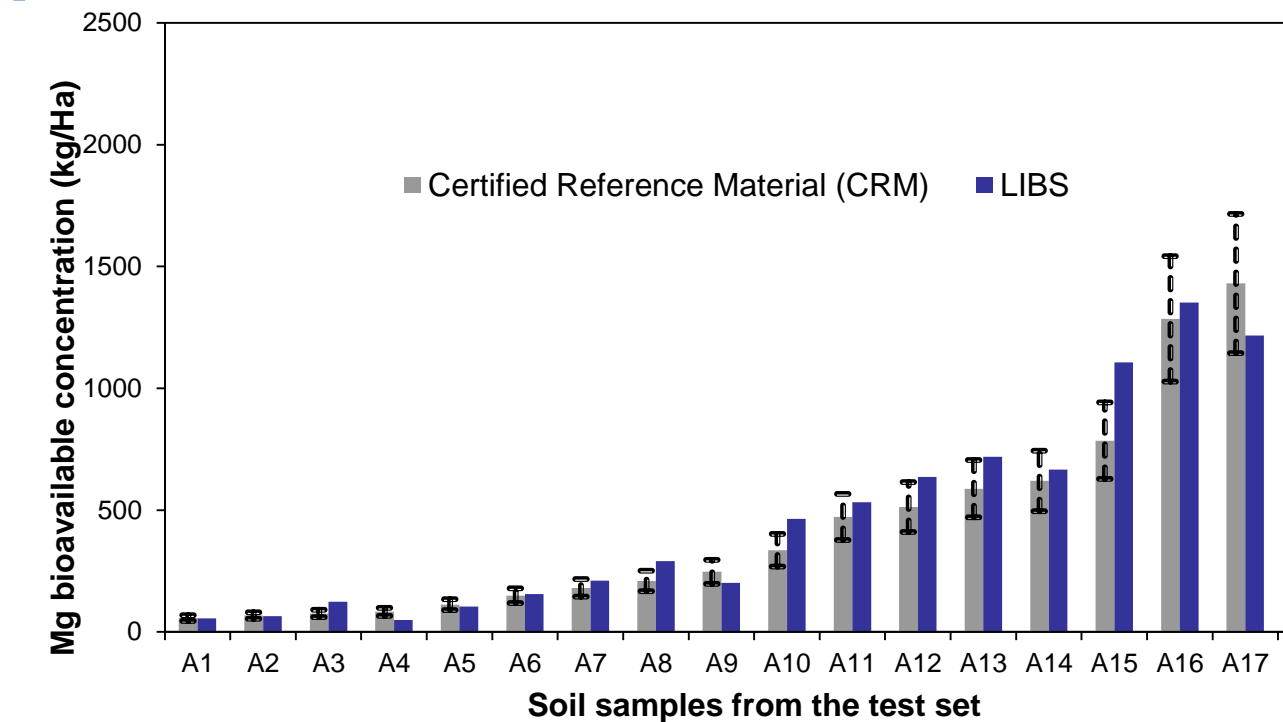
Aluminium



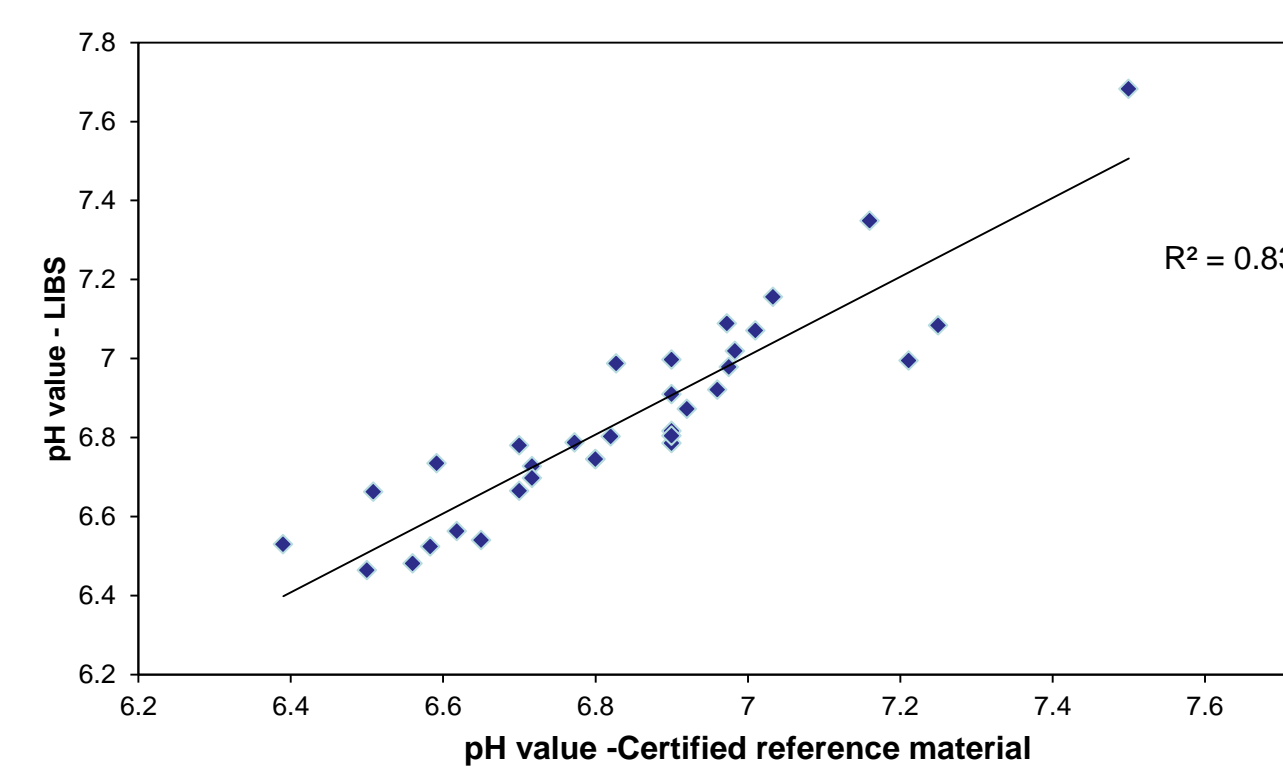
Organic Matter



Magnesium



pH



	Phosphorus (P)		Aluminium (Al)		Organic Matter		Magnesium	
	Calibration set	Test set	Calibration set	Test set	Calibration set	Test set	Calibration set	Test set
R ²	0.951	0.94	0.97	0.9	0.97	0.9	0.97	0.92
RMSE (Kg/ha)	58.16	54.84	59.09	109.09	59.09	109.09	91.42	139.12
Mean relative error (%)	16.76	18.39	4.44	8.25	4.44	8.25	17.62	21.36

- Acceptable accuracy (less than 20% of relative error) according DR-12-CVR of Accreditation Program for Analysis Laboratories (PALA) of Quebec.
- Logiag Inc. is also finalizing the LASERAG system with the **ISO 17025 certification** which confirms the accuracy of the new soil analysis system.

CONCLUSION

- Good precision was obtained for the sample measurements by LIBS equipment, RSD <5%
- Acceptable accuracy was obtained for bioavailability concentrations of major elements by LIBS,
- Acceptable results were obtained for the determination of organic matter and pH of soil samples by LIBS,
- The GPS localization + LIBS system reduce time and costs and result in more detailed fertilizing maps.

OUR PARTNER

