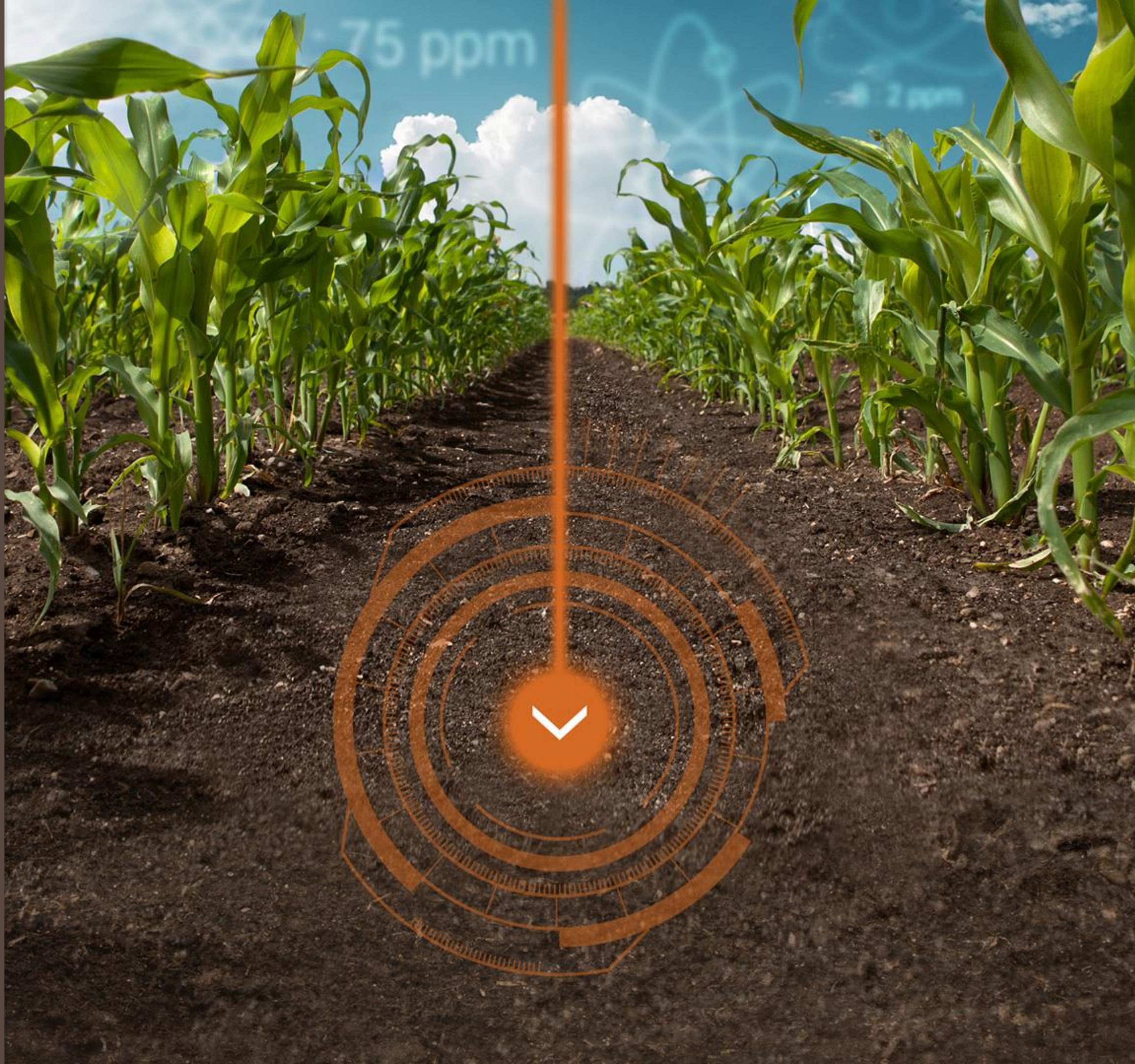
ALTA

AGRICULTURAL LABORATORY TESTING ASSOCIATION

LIBS

- What it is
- How it works
- Soil Organic Carbon
- Let's discuss!



ABOUT LISA PRASSACK

DATA STRATEGIST – DIGITAL AGRI-FOOD, AGTECH & FOODTECH

Lisa Prassack

- CEO, Prassack Advisors LLC
- 12 years in agriculture built on 20+ years in technology
- Education: BS EE/Comp Sci, MBA

Experience

- Global Ag+Food Clients – 100+
- Digital Strategy – 6 Multinationals
- Trimble Ag – Strategy Director
- Agrium - PMO CPS Viterra merger
- DigitalGlobe Energy – Platform
- Private Equity Portfolio Strategies
- Business & Technical Due Diligence
- Board – AgBiTech, Gamaya

Independent Whole Field Research for 4 Manufacturers

Biologicals

- Grower acquisition, data collection and analysis for biological efficacy research
- Bioseed, Biostimulants, Pest Pheromone

Input Manufacturers

- Input & AgTech portfolio optimization
- Analyze AgTech competitive position
- Enterprise digital strategies

Ag Retail

- Analyze agronomy portfolio & competition
- Digital transformation

Equipment OEM

- Machine data collection to track performance, sustainable practice and optimize harvest outcomes

62 Agronomy Tools
40+ IoT Crop Monitors
18 Imagery Solutions
14 Equipment Data Solutions
10 Weather Data Providers

Grower Facing

- Demonstrate grower and input outcomes with aggregate multi-whole field and block analysis

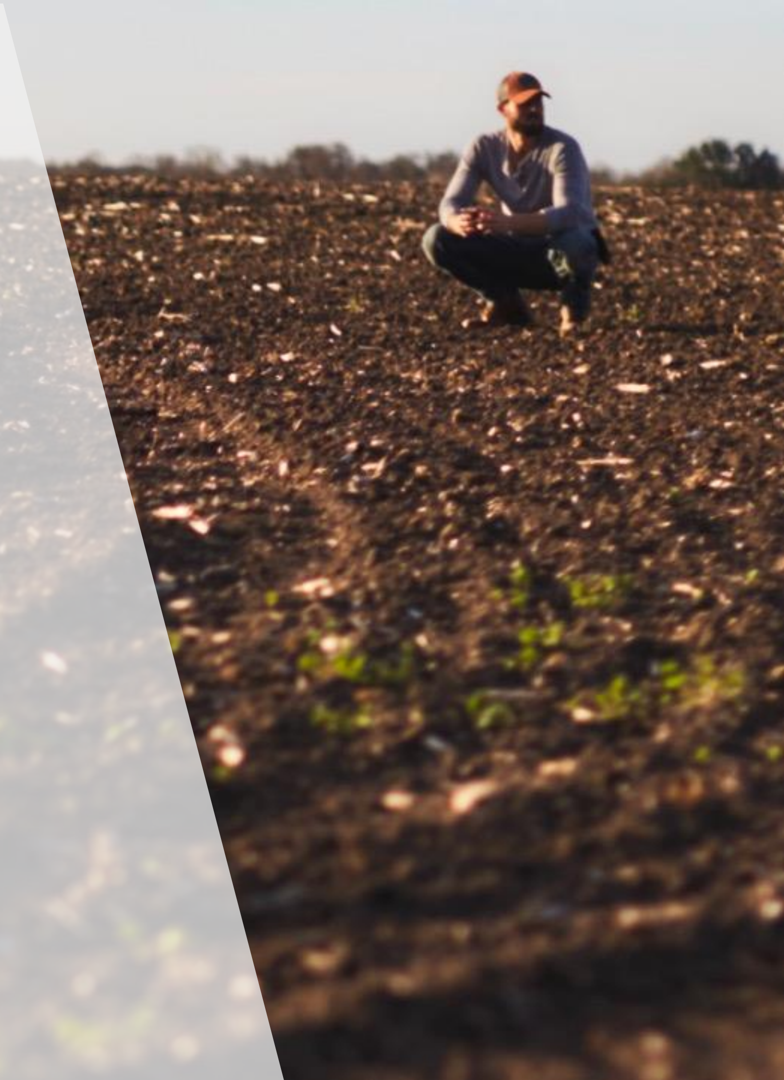
30+ Food & Fiber Brands
5 Large Landholders
16 Soil Labs

Sustain & Trace

- Work with NGOs, grocers, food & fiber brands and technology to deliver grower rankings and consumer data

AGENDA

- WHAT IS LIBS
- CURRENT USES
- SOC VALIDATION
- SOIL ORGANIC CARBON
- LASERAG HIGHLIGHTS



WHAT IS LIBS?

WHAT IS LIBS? Laser Induced Breakdown Spectroscopy

Overview

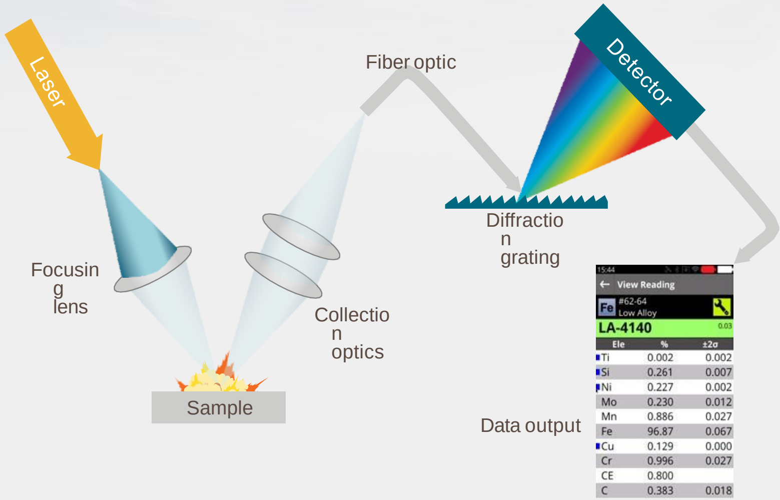
- Uses a high-focused laser to determine the chemical composition of materials.
- Technique is capable of measuring elements, including carbon, for material identification.
- Atomic analysis – elemental. Not molecules: protein, fiber, fat [We use NIR for this.]

- Each element of the periodic table produces a unique LIBS spectral peak.
- By using a detector to measure the unique characteristics of light emitted, it is possible to detect what elements are present within the sample.
- By measuring the sample peaks of light and their intensities, the chemical composition can be rapidly determined and quantified in weight percent concentrations (%).

LIBS Analysis Process

Focused laser interacts with material surface, forms a plasma where material broken down into single elements.

1. Laser pulse pointed at sample surface.
2. Surface is ablated and enters the plasma.
3. Plasma atomizes samples and emit light.
4. Emitted light is transferred through fiber optics and enters the spectrometer.
5. Light is split into single wavelengths/ colors.
6. Single wavelengths/colors hit detector and produce spectral data.
7. 36 ML algorithms determine element content



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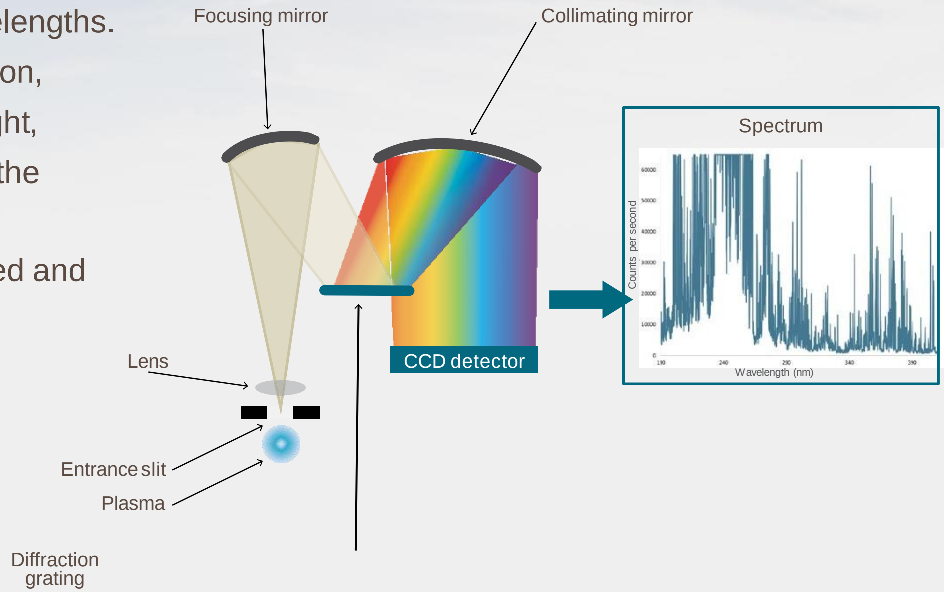
Spectrometer

- Light from plasma contains multiple different wavelengths.
- Light split into component wavelengths by diffraction,
- Different elements emit specific wavelengths of light,
- the intensity of that light is directly proportional to the concentration of element present.
- Peaks represent elements of interest are measured and indicate concentration.



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MODELING METHODS

LINEAR REGRESSION MODEL

DATA STORE
Raw Data
- 12 replicates
- 2D images
- Echelle Spectrometer

FEATURE STORE
- Spectral Extraction

PRE-PROCESSING
- Replicate Average Spectra
- Baseline Removal
- Spectra Intensity Normalized
- X&Y Transforms

REGRESSION
- Feature Normalization

SCORING
- Mean Absolute Error

TREE-BASED REGRESSION MODEL

DATA STORE
Raw Data
- 12 replicates
- 2D - Echelle Spectrometer

FEATURE STORE
- Image Wavelength Realignment
- Spectra Extraction
- Access select emission bands (catalogs)

PRE-PROCESSING
- Baseline Removal
- Spectral Intensity Normalization
- Outlying Replicate Detection
- X & Y Transforms

FEATURE ENGINEERING
- Partial Least Square Features
- Clustering Features
- Join Selected Emission Line Bands
- Join Hardware Measures

REGRESSION
- Gradient boosted decision trees
- Median over replicates

SCORING
- R2 Coefficient
- Relative Error Threshold

CURRENT USES

LIBS SOLUTIONS

LIBS has been proven to effectively analyze:

Forage / Feed Analysis:
Benefit from Certified Quality, Protein and Nutrition Content

Tissue: Rapid, Consistent, High Quality Results

Carbon Management: Grower Incentive and Premium

Soil: Rapid, Consistent, High Quality Results

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LIBS - FORAGE

Macronutrients: "Big Four"

- Calcium – Ca
- Phosphorus – P
- Magnesium – Mg
- Potassium – K

Forage from MSD

- Calcium .44%
- Phosphorous .22%
- Magnesium .21%
- Potassium 1.1%
- Chlorine .13%
- Sodium .23%
- Sulfur .21%

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LIBS + NIR - FORAGE

- **Validation for Mineral Analysis in Forage over Wet Chemistry**
  - Validated for key minerals: ***Ca K, Mg, P and S***
  - Validation of additional minerals: ***Na, Cl***
  - Validation of forage analysis reviewed and accepted for use (based on 5000 samples)

- **Advantages of using the LIBS spectroscopy analysis**
  - Similar to results obtained by wet chemistry,
  - Superior to infrared analysis for elements,
  - Properly monitor and respond to herd feed requirements.

- **Quick & GREEN Analysis with LIBS**
  - Mineral analysis performed on sieved portion of the same ground sample that is used for the infrared analysis.
  - Results are acheived simultaneously with the infrared results, within 24 hours.
  - No environmentally harmful compounds are used in the preparation of samples for LIBS analysis
  - Unlike conventional wet chemistry analysis Only a recyclable plastic cup is used.

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LIBS - FORAGE

	Élément	Calcium	Chlorure	Chlorure +boost	Cuivre	Cuivre +boost	Fer	Fer+boost	Magnésium	Manganèse	Manganèse+boost	Molybdène	Molybdène+boost	Phosphore	Potassium	Sodium	Sodium +boost	Soufre	Zinc	Zinc+boost
Nombre des valeurs > %ER	Nombre total des valeurs	177	179	198	16	18	176	196	177	177	196	97	115	177	177	164	186	176	180	200
	> 5%	140	158	163	15	15	155	156	108	141	145	88	91	134	119	137	147	121	141	155
	> 10%	85	129	132	14	15	121	118	58	104	105	78	70	88	64	105	103	81	111	106
	> 15%	44	109	103	11	10	96	95	35	76	77	65	55	52	34	80	82	52	81	83
	> 20%	23	89	84	6	10	70	73	17	49	52	54	44	30	15	65	58	27	61	61
	> 30%	6	63	56	0	0	40	44	7	30	19	29	18	12	5	35	34	7	31	36
	> 40%	2	46	38	0	0	17	16	1	8	6	9	9	6	4	16	19	0	16	22
	> 50%	0	26	30	0	0	7	9	1	1	1	6	4	1	3	8	9	0	10	12
	> 60%	0	14	21	0	0	5	5	1	1	0	4	1	1	1	4	6	0	4	8
	> 70%	0	8	16	0	0	4	3	1	0	0	0	0	1	0	4	5	0	2	3
	> 80%	0	6	10	0	0	4	2	1	0	0	0	0	0	0	4	5	0	2	2

	Élément	Calcium	Chlorure	Chlorure +boost	Cuivre	Cuivre +boost	Fer	Fer+boost	Magnésium	Manganèse	Manganèse+boost	Molybdene	Molybdene+boost	Phosphore	Potassium	Sodium	Sodium +boost	Souffre	Zinc	Zinc+boost
% des valeurs > %ER	% des valeurs > 5%	79.1	88.3	82.3	93.8	83.3	88.1	79.6	61.0	79.7	74.0	90.7	79.1	75.7	67.2	83.5	79.0	68.8	78.3	77.5
	% des valeurs > 10%	48.0	72.1	66.7	87.5	83.3	68.8	60.2	32.8	58.8	53.6	80.4	60.9	49.7	36.2	64.0	55.4	46.0	61.7	53.0
	% des valeurs > 15%	24.9	60.9	52.0	68.8	55.6	54.5	48.5	19.8	42.9	39.3	67.0	47.8	29.4	19.2	48.8	44.1	29.5	45.0	41.5
	% des valeurs > 20%	13.0	49.7	42.4	37.5	55.6	39.8	37.2	9.6	27.7	26.5	55.7	38.3	16.9	8.5	39.6	31.2	15.3	33.9	30.5
	% des valeurs > 30%	3.4	35.2	28.3	0.0	0.0	22.7	22.4	4.0	16.9	9.7	29.9	15.7	6.8	2.8	21.3	18.3	4.0	17.2	18.0
	% des valeurs > 40%	1.1	25.7	19.2	0.0	0.0	9.7	8.2	0.6	4.5	3.1	9.3	7.8	3.4	2.3	9.8	10.2	0.0	8.9	11.0
	% des valeurs > 50%	0.0	14.5	15.2	0.0	0.0	4.0	4.6	0.6	0.6	0.5	6.2	3.5	0.6	1.7	4.9	4.8	0.0	5.6	6.0
	% des valeurs > 60%	0.0	7.8	10.6	0.0	0.0	2.8	2.6	0.6	0.6	0.0	4.1	0.9	0.6	0.6	2.4	3.2	0.0	2.2	4.0
	% des valeurs > 70%	0.0	4.5	8.1	0.0	0.0	2.3	1.5	0.6	0.0	0.0	0.0	0.0	0.6	0.0	2.4	2.7	0.0	1.1	1.5
	% des valeurs > 80%	0.0	3.4	5.1	0.0	0.0	2.3	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.7	0.0	1.1	1.0

NO more than 5% of results have more than 30% relative error.

LIBS - TISSUE

- **Validation for Mineral Analysis in Forage**
  - Validated for key minerals: ***Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sodium***
  - Validation for other minerals: ***Sulfur, Iron, Zinc, Boron, Copper, Manganese, Molybdenum, Chlorine***
  - Reviewed and accepted for use (2000 samples)

- **Advantages of using the LIBS spectroscopy analysis**
  - Rapid response for potato and berry fertilizer requirements

- **Quick & GREEN Analysis**
  - Mineral analysis is performed on sieved portion of same ground sample that is used for the infrared analysis.
  - Results are acheived simultaneously with the infrared results, within 24 hours.
  - No environmentally harmful compounds are used in the preparation of samples for LIBS analysis
  - Unlike conventional wet chemistry analysis Only a recyclable plastic cup is used.

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LIBS - SOIL ORGANIC CARBON [SOC]

- Validated for Use
- Final Validation August 2022
- **Measures:**
  - % Soil Organic Carbon (SOC)
  - Total Nitrogen
  - % Soil Organic Matter (SOM)
  - pH and Buffered pH
- **Speed**
  - Delivers 1000 samples per day

	Soil Organic Carbon Measurements	
	Two Soil Samples Required	
	Sampling Probe	Sampling Tube 30 x 5 cm dia.
% Soil Organic Carbon (SOC)	✓	X
Soil Bulk Density	X	✓
Soil Texture	✓	X
Total Nitrogen (N)	✓	X
% Soil Organic Matter (SOM)	✓	X
pH and Buffer pH	✓	X

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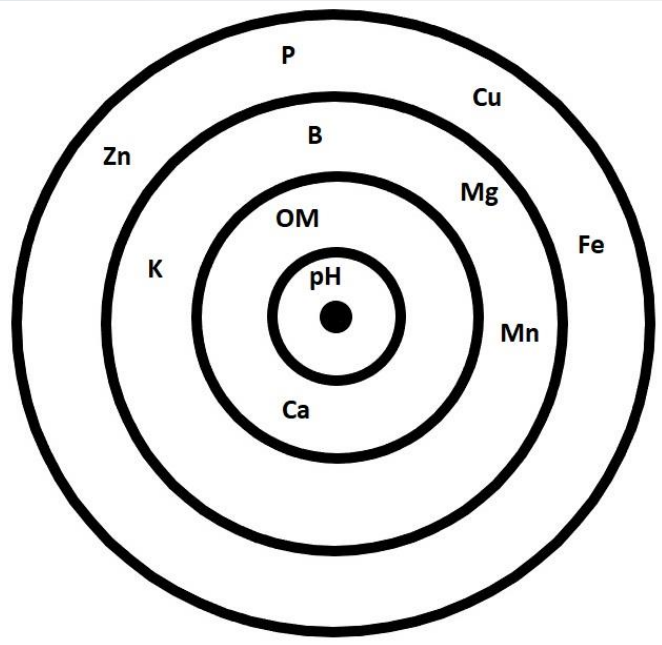
LIBS - SOIL

Target shows where elements fall in accepted difference vs. current soil analysis

- Acceptable Scores
  - pH
  - Calcium
  - Organic Matter
  - Boron
  - Magnesium
  - Manganese
  - Copper
  - Iron
  - Zinc
- Require improved scores
  - Potassium
  - Phosphorous



LIBS - SOIL

Soil analysis has good improvements across all elements – phosphorus and potassium targets are still not met.

- All elements achieved an improved absolute error
- Largest errors are found on small values
- Good improvements on Organic Matter and Phosphorous
- Phosphorous and Potassium targets still not met

Element	R2	Z-SCORE	Z-SCORE	% ACCEPTED DIFFERENCE
Boron	0.58	3.69	**3.90**	18%
Calcium	0.87	4.15	**4.35**	15%
Copper	0.77	2.47	**3.29**	18%
Iron	0.73	3.17	**3.40**	18%
Magnesium	0.71	3.30	**3.41**	15%
Manganese	0.54	3.10	**3.48**	15%
Org Matter	0.75	2.61	**4.05**	10%
pH 1:1	0.82	4.94	**4.94**	10%
Phosphorus	0.46	2.31	**2.70**	15%
Potassium	0.45	3.12	**3.39**	15%
Zinc	0.36	2.60	**3.39**	18%

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MEETING SOC VALIDATION

Table 1. Replicability (%), LOD (%), LOQ (%), relative error (%), accuracy (%), and reference value for C for soil samples with different textures.

	QC15-30		QC15-42		QC15-45	
Model	**Old**	**New**	**Old**	**New**	**Old**	**New**
Replicability (%)	6.46	2.64	8.48	2.75	3.62	2.20
LOD (%)	0.68	0.24	0.77	0.24	0.36	0.18
LOQ (%)	2.28*	0.81*	2.58	0.80	1.19	0.59
Relative error (%)	17.67	3.14	4.55	0.18	31.27	6.37
Accuracy (%)	82.33	96.86	95.45	99.82	68.73	93.63
Reference value	2.14		2.08		1.79	
Texture	Loam		Sand		Clay	

Table 2. Linear range (%), R^2, RMSEP (%), LOQ (%), Upper limit - percentile 0.95% (%), rejected samples with RE > 30% (%), and rejected samples with concentration of analytes above LOQ and RE > 30% for C for different soil samples.

	Old	New
Linear range (%)	0.60 - 4.07	
R^2	0.94	0.91
RMSEP (%)	0.55	**0.31**
LOQ (%)	2.28	0.81
Upper limit - percentile 0.95% (%)	3.52	3.52
Rejected samples with RE > 30% (%)	25	25
Rejected samples with RE > 30%, LOQ (%)*	5	20

*The LOQ value is different for each model, being 1.8 times higher for the old model.

Table 3. RE for C for different soil samples.

Sample	Texture	Reference value	LaserAg			
			Old model		New model	
			Prediction	RE > 30%	Prediction	RE > 30%
MRI003	Clay	1.53	2.22	0.45	2.01	0.31
MRI004	Sand	0.68	0.96	0.42	0.91	0.33
MRI007	Sand	1.06	0.89	0.16	0.88	0.17
MRI009	Sand	0.86	0.87	0.01	0.76	0.12
MRI010	Sand	0.60	0.90	0.51	0.67	0.11
MRI014	Loam	2.94	3.37	0.15	3.02	0.03
MRI015	Loam	1.02	1.31	0.28	1.36	0.33
MRI016	Sand	0.65	0.97	0.49	1.00	0.54
MRI017	Loam	2.97	3.17	0.07	2.82	0.05
MRI021	Loam	2.51	3.03	0.21	2.71	0.08
MRI023	Loam	3.49	4.21	0.21	3.71	0.06
MRI026	Clay	2.28	2.68	0.17	2.28	0.00
MRI027	Sand	1.21	1.00	0.17	0.75	0.38
MRI032	Sand	1.11	0.92	0.17	1.13	0.02
MRI033	Sand	1.00	0.81	0.18	0.83	0.17
MRI034	Sand	1.00	1.04	0.05	1.13	0.14
MRI038	Loam Sand	4.07	5.93	0.46	3.16	0.22
QC15-28	Loam	1.84	2.32	0.26	2.12	0.15
QC15-42	Sand	2.08	1.94	0.07	2.16	0.04
QC15-65	Clay	1.67	2.05	0.23	1.70	0.02

Table 4. Figure of Merits per Climate Package Targetl.

	Carbon	Carbon	Organic Matter	Nitrogen	pH	Buffer pH
Model Type	Local Feature	GBDT	GBDT	GBDT	GBDT	GBDT
Linear range (%)	0.60 - 4.07		1.70 - 8.30	0.05 - 0.41	5.90 - 7.50	6.50 - 7.50
R^2	0.91	0.94	0.94	0.92	0.94	0.93
LOQ (%)	0.81	2.28	3.53	0.13	-	-
RE > 30%, w/ LOQ (%)	20	5	10	0	-	-
AE > 0.2 (%)	-	-	-	-	66.67	66.67

R^2: coefficient of determination
LOQ: limit of quantification
RE: relative error
AE: absolute error

SOIL ORGANIC CARBON

THE OPPORTUNITY:

REFRAME CONSERVATION AS AN OUTPUT OF PRODUCTION FOR REVENUE GENERATION

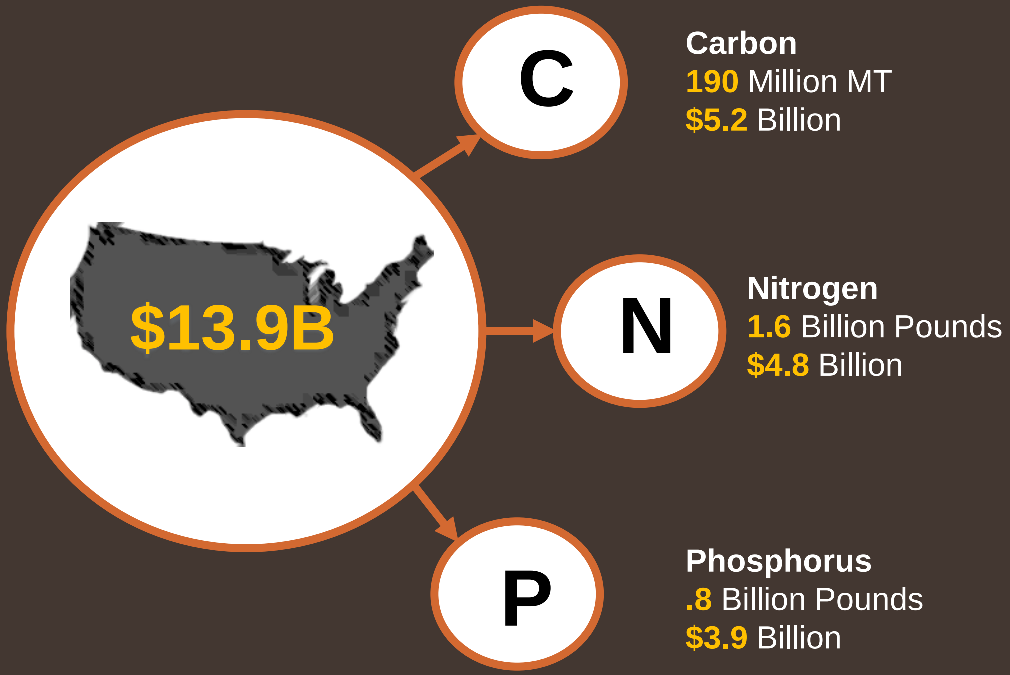
1. **SUPPLY SIDE**

   Monetize soil health to reward growers who adopt and improve environmental management practices.

2. **DEMAND SIDE**
   - Publicly stated goals on environmental impact,
   - Shareholder, stakeholder expectations or
   - Regulatory obligations to improve environment
   - CPG carbon neutral branding.

Source: The Noble Research Institute, IHS MarkIt, ESMC Consortium

U.S. MONETIZE POTENTIAL FOR CARBON AND WATER QUALITY CREDITS



THE PROBLEM:

PUBLIC COMPANIES PRESSURED TO REPORT ESG AND CARBON – THEY NEED DATA THAT IS RELIABLE AND EASY TO REPORT ON THEIR FULL ENVIRONMENTAL IMPACT

1 **LABS**
Historically labor and time intensive

2 **REMOTE SENSING TOOLS**
Still training against ground truth lab samples and not yet accepted as a proxy for carbon credits.

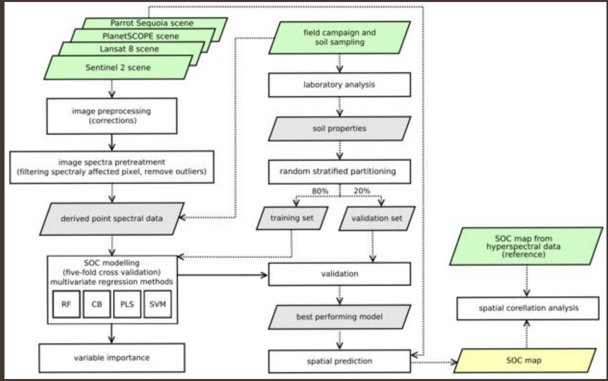
3 **FIELD SENSORS**
Provide detailed accurate data, but are costly and time-consuming to collect at density over large areas.

1 LABS: 2 SAMPLE & TEST TYPES MANUAL INTENSIVE

Dry Combustion: $18-35

Bulk Density: $47 - $100+

2 IMAGERY



3 FIELD SENSORS

THE SOLUTION:

SCALES TO MEET SOIL ORGANIC CARBON DEMAND

LIBS BENEFITS

- Enables operations to meet market demand
- Reduces costs [10X]
- Improves lab turnaround [10X]
- Delivers higher revenue and profit for traditional and emerging lab services
- **Serves other markets:**
  - forage,
  - plant tissue,
  - soil analysis,
  - builds a global soil data layer for analytics and decision-making

TESTIMONIAL

"… analysis costs with LIBS are < 10% of what they are with our conventional line of production, 10 times as fast – and more precise than our traditional lab methods."

- Marc Hamilton, CEO Eurofins Canada

eurofins

NGO AND UN SUSTAINABLE DEVELOPMENT GOALS

As sustainability moves to high data intensity, NGOs will position themselves to partner with companies able to take on “heavy lifting” of measurement, analytics and assertions

TRENDS

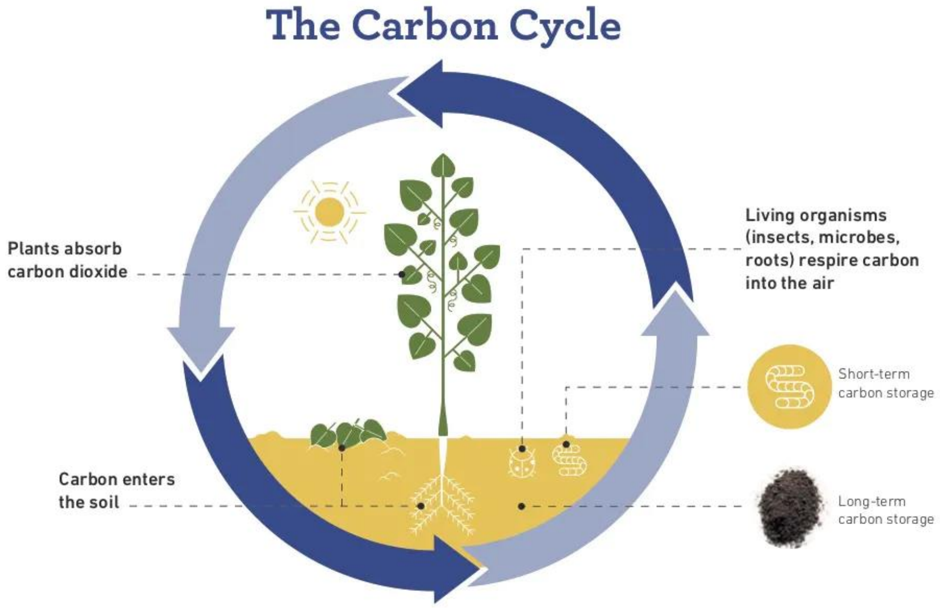
1. To maintain role in measuring outcomes, NGOs must create/anchor widely-accepted ESG metrics
2. Science-led, data-rich corporate partners are most-attractive to NGOs in need of assertion data
3. Focus on NGOs with best track record of transitioning sustainability initiatives to mainstream regulations and practices

CARBON VALUE CHAIN TRENDS

- By measuring, we will discover if farmers can sequester carbon year-on-year or if the process will better enable consumer brands to demonstrate carbon neutrality.

TRENDS

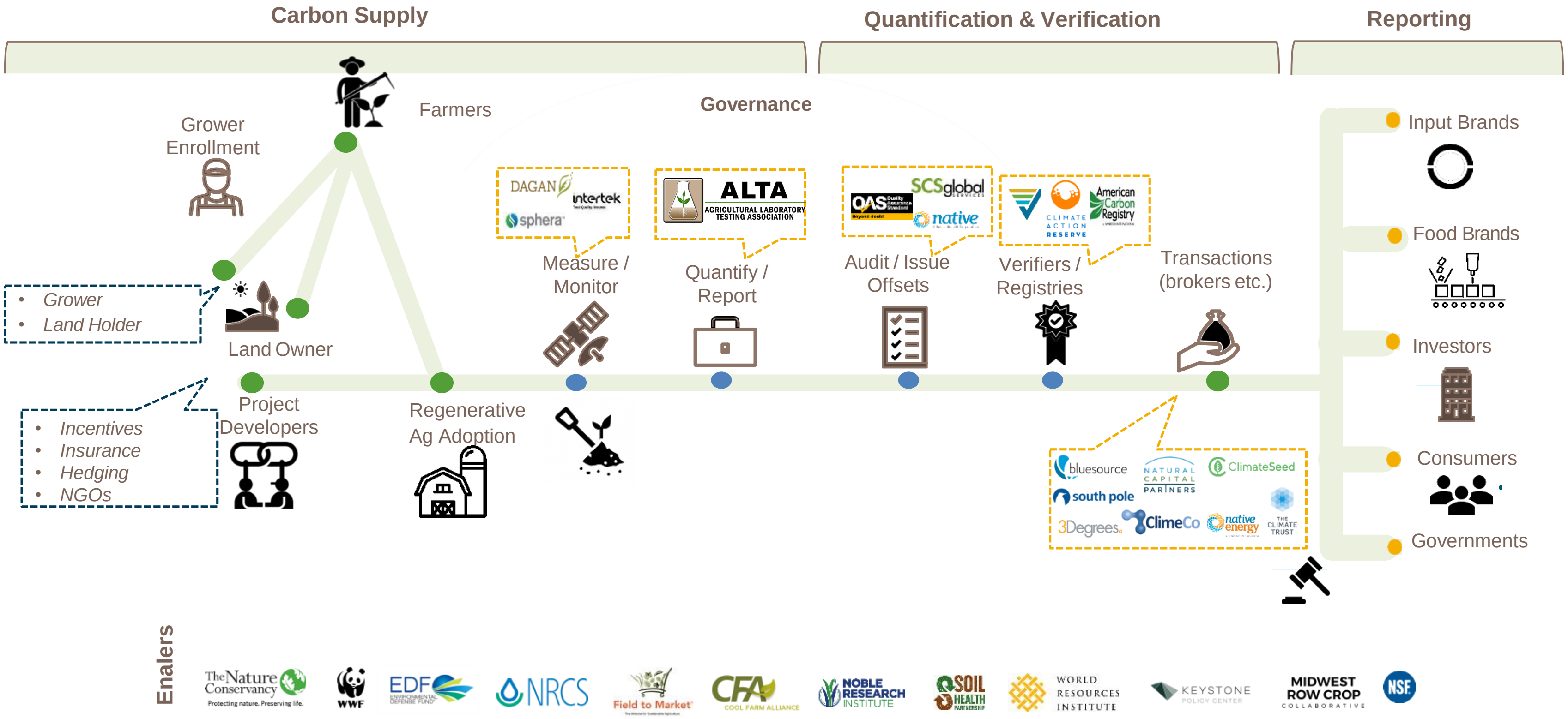
1. Actual carbon removal measurement taking center stage, displacing unquantifiable practices
2. Competition of approaches among forestation / reforestation, soil, biofuel and direct air capture
3. Soil carbon race to determine methodologies showing evidence of sustainable sequestration
4. Some offset buyers may gain more external benefits from creating their own inset programs
5. Market must decide early on if enough carbon sequestration potential to enable voluntary credit



THE CARBON VALUE CHAIN

Food brands want to certify that they are carbon neutral across their supply chain.

PLAYERS
- Crop Production / Supply
- Market Intermediaries
- End-Buyer



AGRICULTURE CARBON SEQUESTRATION PROGRAMS

- **LEADERSHIP:** Leader, operational, scale, market reach
- **GOOD:** Company fulfills expectations
- **MODERATE:** Company fulfills some expectations
- **WEAK**: Company fulfills minimum expectations

Carbon Insets

Company takes direct responsibility for carbon emissions in their own supply chain and improve sustainable management practices at the source.

Carbon Offsets

Offered as carbon credits, based on a reduction in emissions of carbon dioxide or other GHG made in order to compensate for emissions made elsewhere.

Carbon Credit Value

Impacted by grower risk in retaining carbon. Current market values $15-$20 USD. EU over $100. 2030, Canada and Australia have targeted $170 and $130.

Agriculture Carbon Programs

Carbon programs are nascent and early stage. It will be important to track adoption of these programs as well as government movements that may disintermediate some of these programs.

	Ag Inputs	Ag Retail	Ag - Food Processors	Independents				Ind. Regional
	Bayer	Nutrien	Cargill	Indigo	NORI	CIBO	ESMC	Logiag
Program Status	Good	Good	Good	Leadership	Good	Good	Good	Moderate
Program Scale	Moderate	Moderate	Good	Leadership	Good	Good	Moderate	Good
Grower Credit	Moderate	Moderate	Good	Good	Good	Good	Leadership	Good
Payment Rate	Good	Good	Leadership	Good	Good	Good	Moderate	Weak
Additionality	Good	Good	Good	Good	Good	Good	Good	Moderate
Credit Type	Leadership	Moderate	Good	Good	Good	Good	Moderate	Good
Protocols	Good	Good	Good	Good	Good	Moderate	Good	Moderate
Geography | Markets	Good	Good	Leadership	Good	Good	Good	Leadership	Leadership

MICROSOFT'S FY21 CARBON REMOVAL PORTFOLIO

Microsoft wants to support solutions that meet a high standard of verification while maintaining practicality for corporate procurement

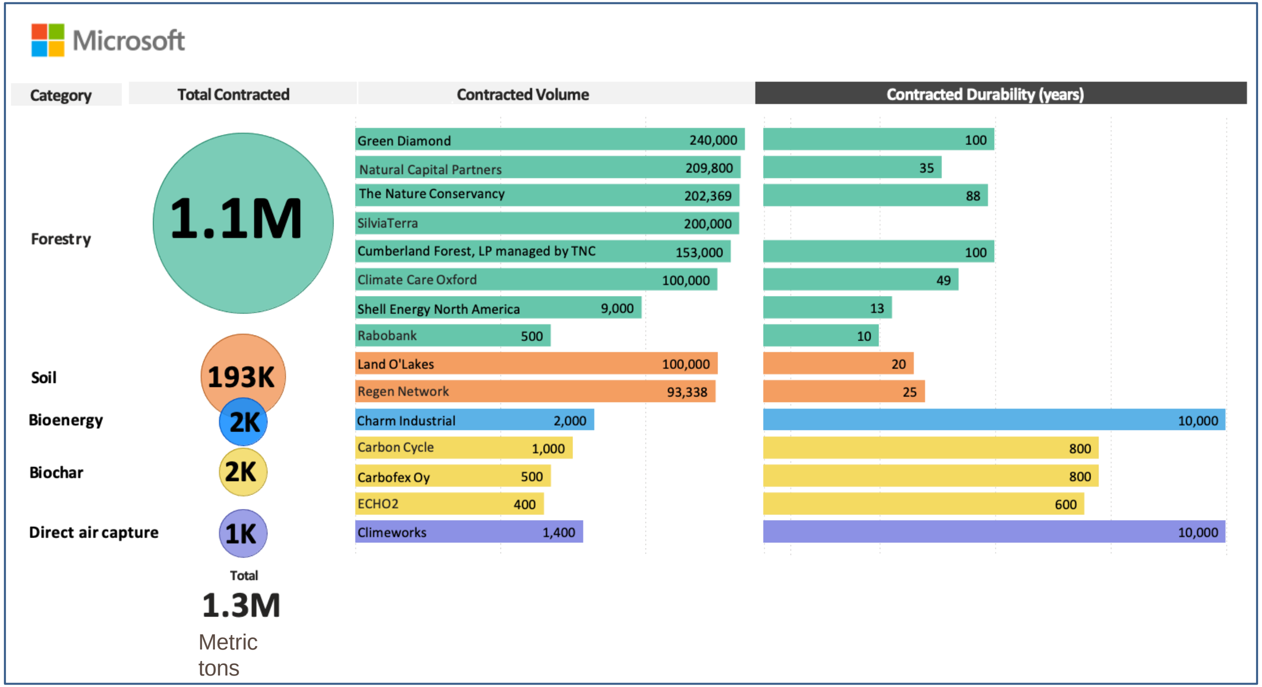
Microsoft

2020 resolution is to become "carbon negative" by 2030. Beyond cutting their own carbon emissions by 6%, they paid for the removal of 1.3 metric tons of carbon – largest corporate purchase ever.

Graphic Outcomes

- **26 Global Projects.** Microsoft is leveraging bioenergy carbon capture and storage (BECCS), direct air capture (DAC), bio-oil, blue carbon
- **Agriculture.** Dominant participant was forestry followed by soil offsets to reach its carbon goals.

- **Negative emissions:** 99.5% of the 1.3m mtCO2 came from temporary nature-based solutions like forest and soil offsets.
- **Climate risk:** Microsoft's sustainability report called for "a widely adopted and comprehensive risk framework." Microsoft is helping to guide processes to identify, assess, and manage climate risks.
- **Transparency:** Microsoft climate effort reports and graphics - demonstrate market-leading transparency and will speed up the learning curve for fast followers seeking net-zero.



- Microsoft chose to purchase carbon credits from 15 suppliers representing 1.3m mt
- CEC prices were assessed at $1.02 per mt of CO2 equivalent at the close Jan. 28, 2021 according to Platts assessments

https://www.spglobal.com/platts/en/market-insights/latest-news/coal/012921-microsoft-buys-13-million-carbon-offsets-in-2021-portfo

INSET - MAPLE LEAF: CARBON NEUTRAL BRANDING

- **PARTNERS:** American Farmland Trust, BASF, Corteva Agriscience, Ingredion, Nutrien, PepsiCo, Syngenta.
- **PURPOSE:** Inset carbon assets for carbon neutral.
- **STANDARDS BODIES:**
  - Climate Action Reserve
  - Verra
  - Gold Standard
- **EXECUTION PARTNERS:**
  - Soil and Water Outcomes Fund
  - Ecosystem Services Market Consortium (ESMC)

CARBON TESTS + REVENUE OPPORTUNITY

By measuring, we will discover if farmers can sequester carbon year-on-year or if the process will better enable consumer brands to demonstrate carbon neutrality.

NEXT STEPS

Ensure recommended practices incenting soil carbon retention launch with measurement capability

Monitor relative “position in race” of soil carbon to forecast uptake of SOC carbon programs

Position to adopt the emerging technologies, even if not part of current approach

Track relative penetration of inset vs. offset, and prepare metrics to incorporate insets in buyer contract

Decide investment in enabling carbon offset market keep an eye on market development

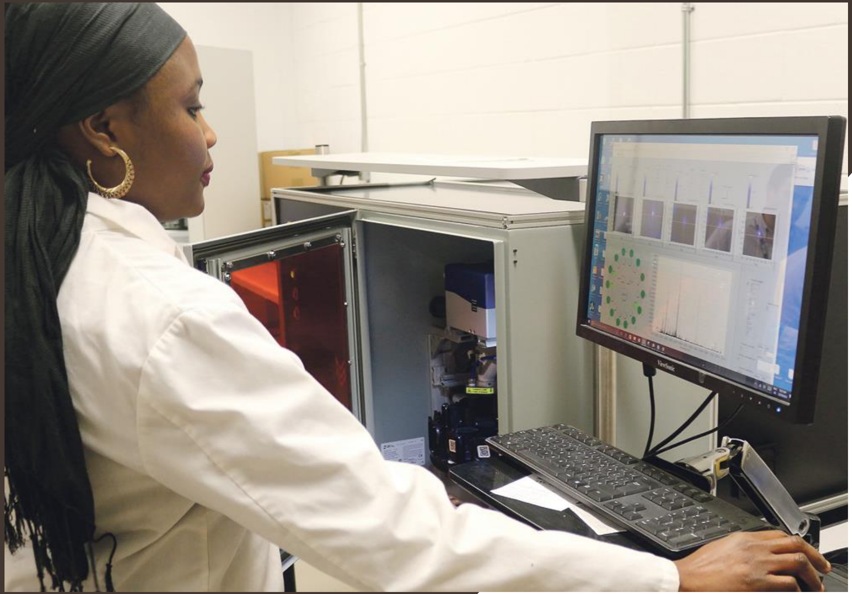
Sample Type	Price
Total Samples	100
Carbon Test	$16-20
Bulk Density	$12-16
pH, Buffer pH, Nitrogen	$20-40
Climate Bundles	$35-50
Sampling Costs	~$20+
Bulk Density Sample Costs	~$50+

LASERAG DETAILS

QUANTUM® LASER TECHNOLOGY

- LaserAg Quantum® platform operates by focusing the spectroscopy laser beam
  - *Atomic emission spectrum of the plasma is used to obtain nutrient concentrations*
  - *Produced by a 8-ns pulsed Nd:YAG laser*
  - *Operates at 1064 nm and 100 Hz* on a small area (120 µm) at the surface of a sample.
- Galvanometer laser scans the sample surface
- Lens-to-sample distance adjustment is made by a laser-based telemetry system.
- Dust accumulation above the sample is removed by an air-based evacuation system.
- Light from the produced plasma is collected axially through a dichroic mirror and then focused into an optical fiber of 400 µm core diameter by means of an achromatic triplet.
- Fourteen samples in QR and geospatial coded cups direct from the field are placed on a 360º rotating carousel for measurements.
- The emission spectra are recorded by a spectrometer with a gated ICCD camera.
- LIBS measurements with chemometric methods provide quantification of nutrient concentrations equivalent to conventional soil test results.
- This dedicated high throughput LIBS analyzer gives soil, plant and forage results faster, more precise and without use of chemicals.

LaserAg Quantum®



UNDERLYING MAGIC

01. POWER OF 10

10X faster and 10% of the cost over traditional methods.

02. AUTOMATION

One lab tech to manage dry, grind, pack and run samples

03. MACHINE LEARNING & PATENTS

Product design, methods and processes are patented.

36 proprietary machine learning models ensure rapid and consistent analysis.

04. NO CHEMICALS

Established support channel and training process, enabling delivery of high standard customer support, making the product durable and reliable.

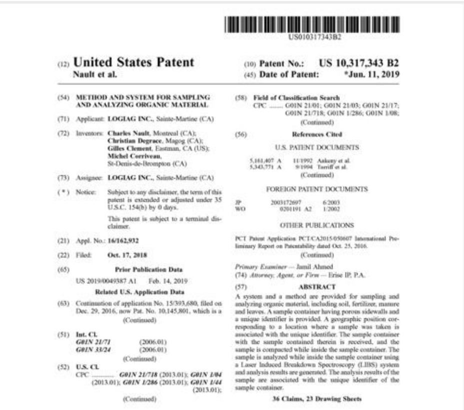
LASERAG PATENTS AND ML

PATENTS

- US10,145,801 B2 in 2019
- US10,316,343 B2 in 2018
- European Patent Office 3161458 in 2021

MACHINE LEARNING ALGORITHMS

- 36 proprietary machine learning models
- Developed in collaboration with CRIM [Computer Research Institute of Montreal]



US010317343B2

(12) United States Patent
Nault et al.

(10) Patent No.: US 10,317,343 B2
(45) Date of Patent: *Jun. 11, 2019

(54) METHOD AND SYSTEM FOR SAMPLING AND ANALYZING ORGANIC MATERIAL

(71) Applicant: LOGIAG INC., Sainte-Martine (CA)

(72) Inventors: Charles Nault, Montreal (CA); Christian Degrace, Magog (CA); Gilles Clement, Eastman, CA (US); Michel Corriveau, St-Denis-de-Brompton (CA)

(73) Assignee: LOGIAG INC., Sainte-Martine (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: 16/162,932

(22) Filed: Oct. 17, 2018

(65) Prior Publication Data

US 2019/0049387 A1 Feb. 14, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/393,680, filed on Dec. 29, 2016, now Pat. No. 10,145,801, which is a

(Continued)

(51) Int. Cl.
G01N 21/71 (2006.01)
G01N 33/24 (2006.01)

(Continued)

(52) U.S. Cl.
CPC G01N 21/718 (2013.01); G01N 1/04 (2013.01); G01N 1/286 (2013.01); G01N 1/44 (2013.01);

(Continued)

(58) Field of Classification Search
CPC G01N 21/01; G01N 21/03; G01N 21/17; G01N 21/718; G01N 1/286; G01N 1/08;

(Continued)

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(Continued)

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(Continued)

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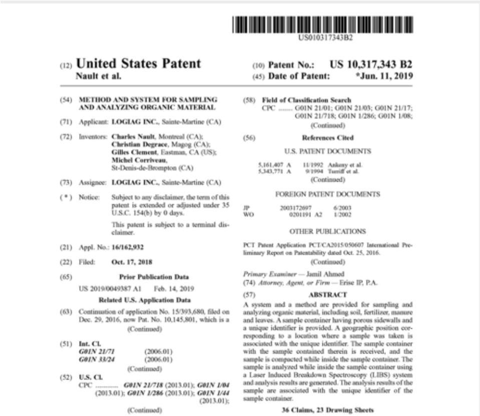
(74) *Attorney, Agent, or Firm* — Erise IP, P.A.

(57) ABSTRACT

A system and a method are provided for sampling and analyzing organic material, including soil, fertilizer, manure and leaves. A sample container having porous sidewalls and a unique identifier is provided. A geographic position corresponding to a location where a sample was taken is associated with the unique identifier. The sample container with the sample contained therein is received, and the sample is compacted while inside the sample container. The sample is analyzed while inside the sample container using a Laser Induced Breakdown Spectroscopy (LIBS) system and analysis results are generated. The analysis results of the sample are associated with the unique identifier of the sample container.

36 Claims, 23 Drawing Sheets



USE LIBS IN LIEU OF CURRENT EQUIPMENT

#	Equipment	Supplier	
1	ICP Optique, for analyzes of Mehlich III	Thermofisher	$140,000.00
2	ICP-MS for the analysis of metals in fodder	Thermofisher or Agilent	$175,000.00
3	iCAP Q & R Supplier	Thermofisher	$ 90,000.00
4	For elements analyzed by combustion	Leco or Trumac CNS	$ 85,000.00
5	Automatic titration for chloride analysis in forage	Mettler Toledo	$ 7,500.00
	Combined maintenance plans	All	$ 50,000.00
	TOTAL INVESTMENT		**$547,500.00**

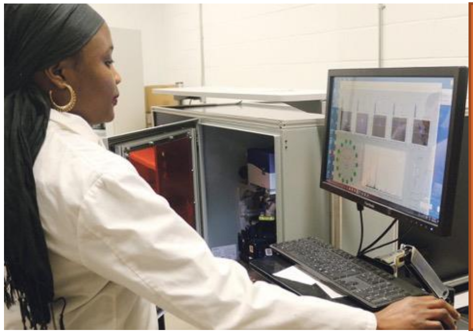
LASERAG BUSINESS MODEL

PER SAMPLE FEE:
RECURRENT REVENUE

HARDWARE:
ONE TIME SALE

FEE STRUCTURE

Like near-Infrared [NIR] for forage protein & fiber analysis



FLEXIBILITY PURCHASE OPTIONS

Buy, Lease, Per sample services

BENEFITS

- 50% of traditional equipment cost
- Uses 10% of the real estate
- Uses 10% of the staff
- No chemicals required

THE COMPANY MILESTONES

LASERAG

Timeline of steady progress and commercialization now requires operating capital to meet market demand.

2010

BEGAN JOINT DEVELOPMENT WITH NATIONAL RESEARCH COUNCIL CANADA

2016

PROTOTYPE RECEIVED ISO 17025 ACCREDITATION

2018 - 2019

LEVEL 9 COMMERCIAL AVAILABLE PRODUCT WITH INO UNITS: OMNIA, EUROFINS, SGS

2020 - 2021

AGRI-FOOD CANADA PURCHASES UNIT
INDIGO CARBON CHALLENGE WINNER
EUROFINS LAUNCHES FORAGE, FOLIAGE

LASERAG DEVELOPMENT PARTNERS

Incubated by LogiAg, an agronomy services company, LaserAg developed the LaserAg Quantum®, in a proprietary collaboration with Canada's NRC, INO, CRIM and MILA

	CRIM	NRC	INO	Mila
Partner	Computer Research Institute of Montréal	National Research Council of Canada	Institut National d'Optique	
	www.crim.ca	nrc.canada.ca	www.ino.ca	mila.quebec
Staffing	Contract with 3 engineers to build 36 patented machine learning algorithms	Contract with 3 engineers with LIBS expertise	Access to up to 12 staff, short run manufacturing of up to 10 units per month.	Contract with 3 engineers to optimize machine learning algorithms and review and improve methods and processes
About	• Mission is to accelerate new technologies to market • Non-profit funded by the ministère de l'Économie et de l'Innovation	• Canada's largest federal research and development organization	• Largest centre of expertise in optics and photonics in Canada • Partnerships with the Ministère de l'Économie et de l'Innovation and Canada Economic Development for Quebec Regions	• Research institute in artificial intelligence with 500 researchers specializing in machine learning • Non-profit organization, partnership between the Université de Montréal and McGill University, closely linked with Polytechnique Montréal and HEC Montréal (2017)
Location	Montréal	Montréal	Québec City	Montréal

Questions?

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**To learn more about the LaserAg Quantum®
visit our website at www.laserag.com
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