New Brunswick Soil & Crop Improvement Association Inc.
2-150 Woodside Lane Fredericton, NB E3C 2R9
el: 506-454-1736   Fax: 506-453-1985 www.nbscia.ca

CANADIAN AGRICULTURAL PARTNERSHIP

Enabling Agricultural Research and Innovation

Element 1, Innovative Research and Development Report

1. *Project title and project number*: NB Crop Production Optimization C1920-0035-Y2

2. *Project leader and collaborators*:
Ray Carmichael, NBSCIA Agrologist, serves as Project Leader.
Karon Cowan, owner of AgTech GIS, yield mapping and summary
Bill Jones, Geomatics Analyst, exp., provides mapping and geospatial modeling support
Zach Harmer, Practical Precision Inc. Tavistock, Ontario, SoilOptix support
Ryan Callahan, McCain Fertilizers Ltd. SoilOptix field operations
Shawn Paget, Riverview Farms Corporation, owner/operator – potato, soybean and grain yield data

ABSTRACT/RÉSUMÉ:

Maximum yield is necessary for producers to be economically viable in the agricultural sector. One of the technological advancements that lets producers optimize their yield are yield monitors mounted directly on combines and harvesters. In 2015, the NBSCIA implemented ArcGIS and SMS GIS, which allows local management of New Brunswick crop data, as opposed to sending the data elsewhere to be analyzed. This database helps improve crop yields as well as guiding producers to more environmentally conscious cropping decisions. Therefore, this project aims to encourage adoption of crop production management technology for NB crops, improve knowledge and understanding for all stakeholders, to quantify potential for yield improvements, identify primary soil chemical and physical characteristics that contribute to in-field variability, and to document cost-benefit of variable rate application of time and fertilizer over time. In the King and Moncton regions, data was collected on yields through hectare grid sampling, SoilOptix® data, and JD Operations data through AgTech GIS. The data was compiled into maps for analysis. Through the 4R recommendations and the in-field variance data, it was established that in 2020, for the test sites of this study, 95% of all field area could be improved upon using these methods and technologies, compared to only 80% in 2019. This study shows that the SoilOptix® method provides a much higher resolution of soil properties than the traditional hectare sampling method. It can also analyze more aspects of the soil. Sample grids can be created by SMS operators for each field which makes coordination of soil samples more accessible. This method amasses huge amounts of data which can be further analyzed and used to make the yields more competitive. In the future, building a solid Provincial GIS database of field status will be essential. Having multiple years of field data will be beneficial for each producer.

Les producteurs doivent parvenir à un rendement maximal pour être économiquement viables dans le secteur agricole. L'une des avancées technologiques qui permettent aux producteurs d'optimiser leur rendement est le capteur de rendement intégré aux moissonneuses et aux récolteuses. En 2015, l'AASCNB a mis en place les systèmes ArcGIS et SMS GIS, permettant une gestion locale des données sur les cultures du Nouveau-Brunswick, sans avoir à transmettre ces données ailleurs aux fins d'analyses. Cette base de données permet d'améliorer le rendement des cultures, mais aussi d'orienter les producteurs vers des choix de cultures plus respectueux de l'environnement. Ce projet vise donc à encourager l'adoption de la technologie de gestion de la production des cultures du N.-B., à améliorer les connaissances et la compréhension de toutes les parties prenantes, à quantifier le potentiel d'amélioration des rendements, à identifier les principales caractéristiques chimiques et physiques du sol qui contribuent à la variabilité dans

les champs, et à documenter les coûts-avantages de l'application de taux variables de temps et d'engrais au fil du temps. Dans les régions de King et de Moncton, des données ont été recueillies sur les rendements au moyen d'un échantillonnage en grille d'hectare, de données SoilOptix® et de données JD Operations par le biais du système d'information géographique AgTech. Les données ont été compilées sous forme de cartes pour fins d'analyse. Grâce aux recommandations sur les 4R et aux données de variance sur le terrain, il a été établi qu'en 2020, dans le cas des sites témoins de cette étude, 95 % de l'ensemble des surfaces de terrain pourraient être améliorées au moyen de ces méthodes et technologies, comparativement à seulement 80% en 2019. L'étude révèle que la méthode SoilOptix® offre une résolution beaucoup plus élevée des propriétés du sol que la méthode traditionnelle d'échantillonnage à l'hectare. Elle permet également d'analyser davantage d'aspects du sol. Les exploitants du système SMS peuvent créer des grilles d'échantillonnage pour chaque champ, en rendant plus accessible la coordination des échantillons de sol. Cette méthode permet de rassembler d'énormes quantités de données susceptibles d'être analysées et exploitées afin de rendre les rendements plus performants. La création d'une solide base de données SIG provinciale sur l'état des champs sera essentielle à l'avenir. Chaque producteur aura avantage à disposer de plusieurs années de données sur les champs.

3. <u>Summary</u>.

A key element of the NBSCIA mandate is to support farms with quality services and leadership in environmental awareness and crop production management to foster an agricultural industry that is environmentally sustainable, responsive to the impacts of climate change and contributes to a reduction in the emission of greenhouse gases.

The range of crop yield within a field is readily apparent to the naked eye, however such variability as observed cannot be quantified without some type of harvester mounted monitor.

The objectives for the project activity are:

1. To accelerate the adoption and utilization of commercially available crop production management technology or Precision Farming tools for forage, cereal, corn, soybean and potato crop management in New Brunswick.
2. To improve the knowledge and understanding of georeferenced data management and interpretation within the New Brunswick agricultural stakeholder community (producers, government specialists and service providers).
3. To quantify the potential yield improvement for forages, grains, oilseeds and potatoes in New Brunswick.
4. To identify primary soil chemical and physical characteristics limiting crop yield that may contribute to in-field yield variability.
5. To document the crop yield improvement or cost-benefit of implementing variable rate application of lime and fertilizer inputs over time.

Project deliverables included:

- Quantification of the potential yield improvement for forage, cereal, corn, soybean and potato crops within existing field units.
- Definition or identification of correlation between crop yield and soil chemical and physical characteristics.
- Definition of optimum management zone size to accommodate commercial application and harvesting equipment swath widths.
- Demonstration of crop yield improvement with site specific fertility management (variable rate application of inputs).

- Distribution of the results to all industry stakeholders via e-mail, inclusion on the NBSCIA website and in the annual report.
- Presentations of the yearly and composite results at producer, Local and NBSCIA meetings will be as requested bases.

Forage yield data was collected from five farms using Greenleaf Harvesting and one farm with grain combine and potato yield monitors and interpolated in 2D and 3D layouts

The potential for in-field yield improvement varied between the six crop types reported in 2020. However, over the total crop area of 1240 acres the average yield improvement potential for all crop species was approximately 95% compared to 80% of the field area in 2019. Approximately 5% of the field area was considered to have a limited potential for yield improvement in 2020 compared to 20% in 2019. Much of this difference can be attributed to the adverse growing conditions experienced during the 2020 growing season.

Future years of yield information from the subject fields should be collected and incorporated with lime and fertilizer application maps to study the magnitude of improvement and potential for long term sustainability.

4. *Introduction:*

Maximum economic yield (MEY) for any crop is essential for the profitability of the agriculture industry stakeholder involved in crop production. The recent development of combine and harvester (forage and potato) mounted yield monitors has made the collection of geo-referenced crop yield data readily available in New Brunswick. When combined with geo-referenced soil analysis and variable rate application technology the capability to optimize crop production for environmental and economic sustainability has never been greater.

NB farmers with the support of Government programming have made considerable investments in hardware components associated with precision farming technology, particularly for guidance, auto-steering and yield monitoring. However, exploiting the data collected or otherwise available is limited by the availability of local expertise from input suppliers or independent consultants to prepare the analysis and interpret the "digital agronomy". To date much of the local correlation and interpolation of the available data has remained within the academic community. Commercially the majority of such analysis is provided externally through cloud computing services provided by machinery and chemical supply companies using agronomists somewhat removed from New Brunswick.

A key element of the NBSCIA mandate is to support farms with quality services and leadership in environmental awareness and crop production management to foster an agricultural industry that is environmentally sustainable, responsive to the impacts of climate change and contributes to a reduction in the emission of greenhouse gases.

In 2015 NBSCIA initiated a project activity to improve the overall geomatics services offered to farmers through the NBSCIA agro-environmental clubs. This project not only improved the quality and accuracy of base maps prepared for farmers in environmental management applications but provided the capability to support members in adopting Precision Farming technologies such as geo-referenced soil sampling mapping and variable rate lime and fertilizer application recommendations. Using ArcGIS and SMS GIS, NBSCIA can now support local data management by production specialists familiar with crop production in New Brunswick.

With the increasing pressure to improve environmental sustainability and increase economic efficiency farmers are continuously looking for ways to better manage their land base to provide a maximum economic yield. Evolving techniques associated with precision farming enable tailoring traditional production recommendations and cropping methods within the field to optimize yield.

The range of crop yield within a field is readily apparent to the naked eye, however such variability as observed cannot be quantified without some type of harvester mounted monitor. Grain combine and potato harvester yield monitors have been utilized in NB since 2000. The recent innovation of forage harvester yield monitors has made the collection of similar geo-referenced forage crop yield data possible.

Determination of the magnitude of crop yield variability provides valuable insight into strategies to optimize crop production in New Brunswick. Assembling this geo-referenced data in a single database enables the quantification of crop yield improvement from the lowest to highest yield zone within each field and the potential for improvement through management. Correlation of these relative yield zones with other factors such as fertility, elevation or slope can identify one or more particular controlling factors.

Commercially available proximal soil sensing devices allow rapid and inexpensive mapping of soil properties at relatively high spatial resolution, and therefore are suitable for delineation of management zones. The SoilOptix® system provides an in-depth analysis of soil with a resolution of approximately 335 points per acre providing agronomists and growers a deeper understanding of the variability in fertility and textural-based properties of their soil, including an estimate of plant available water (PAW) and infiltration.

5. *Project Objective(s):*

1. To accelerate the adoption and utilization of commercially available crop production management technology or Precision Farming tools for forage, cereal, corn, soybean and potato crop management in New Brunswick.
2. To improve the knowledge and understanding of georeferenced data management and interpretation within the New Brunswick agricultural stakeholder community (producers, government specialists and service providers).
3. To quantify the potential yield improvement for forages, grains, oilseeds and potatoes in New Brunswick.
4. To identify primary soil chemical and physical characteristics limiting crop yield that may contribute to in-field yield variability.
5. To document the crop yield improvement or cost-benefit of implementing variable rate application of lime and fertilizer inputs over time.

6. *Project Deliverable(s):*

- Quantification of the potential yield improvement for forage, cereal, corn, soybean and potato crops within existing field units
- Definition or identification of correlation between crop yield and soil chemical and physical characteristics.
- Definition of optimum management zone size to accommodate commercial application and harvesting equipment swath widths
- Demonstration of crop yield improvement with site specific fertility management (variable rate application of inputs).
- Distribution of the results to all industry stakeholders via e-mail, inclusion on the NBSCIA website and in the annual report.
- Presentations of the yearly and composite results at producer, Local and NBSCIA meetings will be as requested bases.

7. *Material and Methods*:

NBSCIA coordinators undertook hectare grid sampling and prepared the maps using the in-house SMS software on four farms covering approximately 130 acres in the Kings and Moncton regions.

McCain Fertilizer collected SoilOptix data from four fields in the Kings and Moncton regions, approximately 209 acres.

AgTech GIS exported the yield data from the JD Operations center and prepared 2D and 3D crop yield maps and established the NBSCIA SMS database. NBSCIA staff calculated the magnitude of crop yield improvement for the 2020 season and a comparison to 2019 season.

AgTech GIS also provided a textural classification of using the USDA triangle in SMS from the SoilOptix® data collected in 2019 and 2020.

exp conducted a geospatial analysis of elevation comparison to Lidar geostatistical analysis, interpretation and ArcGIS support.

Appropriate remediation was recommended for variable rate applications of lime and fertilizer following the 4R principles on one forage demonstration site.

The data collected and derived on crop performance and soil characteristics is stored in the SMS platform in the NBSCIA geomatics data center and within the limits of confidentiality, provided to interested researchers for additional analysis and interpretation. All mapped products were delivered to participating cooperators.

8. *Results and Discussion*:
A number of farms with combine yield monitors were invited to participate, however for various technical reasons with the systems a limited number of fields actually recorded quality data. Aside from monitor calibration, the most significant issues appear to be consistent field identification in the JD Operations center and continuous operation of the yield monitoring units across the entire field area.

Yield maps were prepared for all crops in all project fields and interpolated in 2D and 3D layouts as presented in Appendix Illustrations 1 and 2.

Forage yield data was collected from three farms using Greenleaf Harvesting. Feed quality values for corn silage and forage crops from the John Deere HarvestLab™ JD Lab were also reported similarly to project C1920-0035 (2019).

In total forage yield was collected for 144 acres and the within field potential yield improvement was estimated to average 1.2 ton per acre compared to1.1 ton per acre of forage dry matter in 2019 as presented in Table 1 below.

Corn silage yield was collected from four fields totalling 143 acres and a within field potential yield was estimated to average 3 ton per acre compared to 2.6 ton per acre of dry matter in 2019 as reported in Table 2 below.

Soybean yield was collected from five fields totalling approximately 349 acres and within field potential yield improvement was estimated to average 28.3 compared to 26.9 bushel per acre in 2019, as reported in Table 3 below.

Oat yield was collected from six fields totalling approximately 319 acres and within field potential yield improvement was estimated to average 28.9 bushel per acre compared to 10.9 bushel per acre in 2019, as reported in Table 4 below.

Grain corn yield was collected from three fields totalling approximately 132 acres and within field potential yield improvement was estimated to average 38 bushel per acre compared to 32.5 bushel per acre in 2019, as reported in Table 5 below.

Potato yield was collected from four fields totalling approximately 155 acres and within field potential yield improvement was estimated to average 100 cwt per acre as reported in Table 6 below.

The potential for in-field yield improvement varied between the crop species reported in 2020. Over the total crop area of approximately 1200 acres the average yield improvement potential was approximately 95% compared to 80% in 2019, as reported in Table 7 below. This difference might possibly be attributed to the adverse growing conditions experienced in 2020.

New Brunswick Soil & Crop Improvement Association Inc.
2-150 Woodside Lane Fredericton, NB E3C 2R9
el: 506-454-1736 Fax: 506-453-1985 www.nbscia.ca

CANADIAN AGRICULTURAL PARTNERSHIP

Table 1: Forage Potential Yield Improvement by Field Area

															POTENTIAL IMPROVEMENT**							
			Dry Matter Yield Range (Tons) x Area						% of Field Area						(Tons)						Total	Per Ac
Farm	Field	Area	< 1.0	1-1.5	1.5-2	2-2.5	2.5-3.0	>3.0	< 1.0	1-1.5	1.5-2	2-2.5	2.5-3.0	>3.0	2.5	1.5	1	0.5	0	0		
	2019 Middle	59	17	30.4	11.3	0.3	0	0	28.8	51.5	19.2	0.5	0.0	0.0	42.5	45.6	11	0.15	0	0	99.6	1.7
	SouthGordon	12.7	2.2	2.1	2.1	2.1	2.1	2.1	17.3	16.5	16.5	16.5	16.5	16.5	5.5	3.15	2.1	1.05	0	0	11.8	0.9
	Top of Hill	32.6	5.4	5.4	5.4	5.5	5.5	5.4	16.6	16.6	16.6	16.9	17	17	14	8	5	3	0	0	30	1
Lower2019	1st	85.5	6.1	15.4	24.9	26.1	9.8	3.2	7.1	18.0	29.1	30.5	11.5	3.7	15.3	23.1	25	13.1	0	0	76.3	0.9
Lower2019	3rd	45.8	15.6	19.2	9.6	1.2	0.1	0.1	34.1	41.9	21.0	2.6	0.2	0.2	39.0	28.8	9.6	0.6	0	0	78	1.7
McCain2020	1st	12.8	2.1	2.1	2.1	2.1	2.1	2.3	16.4	16.4	16.4	16.4	16.4	18.0	5.3	3.15	2.1	1.05	0	0	11.6	0.9
			Dry Matter Yield Range (Tons)						% of Field Area						(Tons)						Total	Per Ac
			<.5	.53-.64	.64-.76	.76-.91	.91-1.1	1.1-3.3	<.5	.53-.64	.64-.76	.76-.91	.91-1.1	1.1-3.3	2.9	2.71	2.6	2.44	2.3	0		
Lower2020	1st	85.5	14.5	14.4	14.3	14.2	14.2	13.9	17.0	16.8	16.7	16.6	16.6	16.3	41.3	39	37	34.6	32	0	184	2.2
Total								**Avg.=**	**19.6**	**25.4**	**19.4**	**14.3**	**11.2**	**10.2**	**Overall Field Area Average(ton/ac):**							**1.3**

*adjusted for yield potential to next highest range only

Low yield range not adjusted for uncropped areas,swath width variance.

High yield range not adjusted for machine stops , swath width variance.

** Potential yield improvement calculated to second highest range recorded,except Lower 2020.

Table 2: Corn Silage In-field Potential Yield Improvement for Field Area

															POTENTIAL IMPROVEMENT*							
			Dry Matter Yield Range (Tons) x Area						% of Field Area						(Tons)						Total	Per Ac
Farm	Field	Area	< 4.0	4-6	6-8	8-10	10-12	>12	< 4.0	4-6	6-8	8-10	10-12	>12	3	6	4	2	0	0		
2019	Meadows1	75.9	0.3	5	19.1	46.4	5	0.1	0.4	6.6	25.2	61.1	6.6	0.1	0.9	30	76	92.8	0	0	200.1	2.6
2020	Meadows1	18.6	0	0.9	8.5	8	1.2	0	0.0	4.8	45.7	43.0	6.5	0.0	0.0	5.4	34	16	0	0	55.4	3.0
2018	Apohaqui	63.4	0	0.5	17.5	44.1	1.3	0	0.0	0.8	27.6	69.6	2.1	0.0	0.0	3	70	88.2	0	0	161.2	2.5
2019	Apohaqui	63.4	0	0.8	6.2	25.7	29.3	1.4	0.0	1.3	9.8	40.5	46.2	2.2	0.0	4.8	25	51.4	0	0	81	1.3
2020	Apohaqui	63.4	0.6	3.1	28.6	29.9	0.9	0.3	0.9	4.9	45.1	47.2	1.4	0.5	1.8	18.6	114	59.8	0	0	194.6	3.1
2020	Meadows8	24.4	0.1	4.3	16.2	3.8	0	0	0.4	17.6	66.4	15.6	0.0	0.0	0.3	25.8	65	7.6	0	0	98.5	4.0
2020	PicNMulb	36.6	0	0.2	4.7	27.8	3.6	0.3	0.0	0.5	12.8	76.0	9.8	0.8	0.0	1.2	19	55.6	0	0	75.6	2.1
	Total	**346**						**Avg.=**	**0.3**	**5.2**	**33.2**	**50.4**	**10.4**	**0.5**	**Overall Field Area Average(ton/ac)**							**2.7**

*Potential improvement calculated to second highest yield range recorded for all fields.

Yield ranges not adjusted for machine stops , swath width variance.

Table3: Soybean In-field Potential Yield Improvement for Field Area

															POTENTIAL IMPROVEMENT*							
			Area x Yield Range (bu)						% of Field Area						(bu)						Total	Per Ac
Farm	Field	Area	<20	20-30	30-40	40-50	50-60	>60	< 20	20-30	30-40	40-50	50-60	>60	15	30	40	10	0	0		
2019	SD3	48.2	2.2	9.9	23.8	10.9	1.3	0.1	4.6	20.5	49.4	22.6	2.7	0.2	33	297	952	109	0	0	1391	28.9
2019	GB1	22.5	6.4	11.1	2.8	1.2	0.4	0.6	28.4	49.3	12.4	5.3	1.8	2.7	96	333	112	12	0	0	553	24.6
2019	RD1	112.1	4.4	63.8	38.5	3.9	0.7	0.8	3.9	56.9	34.3	3.5	0.6	0.7	66	1914	1540	39	0	0	3559	31.7
	Total:	182.8						**Avg:**	12.3	42.3	32.1	10.5	1.7	1.2	**Overall Field Area Average(bu/ac):**							28.4
2020	FR1	42.0	0.2	2.7	11.3	19.7	6.5	1.6	0.5	6.4	26.9	46.9	15.5	3.8	3	81	452	197	0	0	733	17.5
	FR2	15.3	0.1	2.3	8.6	3.8	0.3	0.2	0.7	15.0	56.2	24.8	2.0	1.3	2	69	344	38	0	0	453	29.6
	FR3	46.4	0.4	4.3	18.4	17.2	5.1	1	0.9	9.3	39.7	37.1	11.0	2.2	6	129	736	172	0	0	1043	22.5
	FR9	42.4	0.4	8.8	29.3	2.9	0.5	0.5	0.9	20.8	69.1	6.8	1.2	1.2	6	264	1172	29	0	0	1471	34.7
	KT1	79.6	6.7	34.5	31.4	5.7	0.9	0.4	8.4	43.3	39.4	7.2	1.1	0.5	101	1035	1256	57	0	0	2449	30.8
	NG1-2	98.4	7.6	43.7	38.6	6.2	1	1.3	7.7	44.4	39.2	6.3	1.0	1.3	114	1311	1544	62	0	0	3031	30.8
	MF1	25.2	0	4.1	15.8	4.4	0.6	0.3	0.0	16.3	62.7	17.5	2.4	1.2	0	123	632	44	0	0	799	31.7
	Total:	**349.3**						**Avg:**	**2.7**	**29.5**	**42.0**	**17.1**	**3.7**	**1.5**	**Overall Field Area Average(bu/ac):**							**28.3**

*Potential improvement calculated to second highest yield range recorded for the field.

Lowest yield range potential improvement adjusted by 1/2 for uncropped areas,swath width variance.

Higher yield ranges not adjusted for machine stops , swath width variance.

Table 4: Oat In-field Potential Yield Improvement for Field Area

			Area x Yield Range (bu)						% of Field Area						POTENTIAL IMPROVEMENT* (bu)						Total	Per Ac
Farm	Field	Area	<75	75-95	95-105	105-115	115-125	>125	<75	75-95	95-105	105-115	115-125	>125	50	30	20	10	0	0		
2020	GB2	62.9	16	31.8	8.6	3.5	2.9	0.5	24.8	50.6	13.7	5.6	4.6	0.8	780	954	172	35	0	0	1941	30.9
2020	GB1	19.6	1.4	9.2	4.9	2.9	0.5	0.7	7.1	46.9	207.1	35.7	50.0	3.6	70	276	98	29	0	0	473	24.1
2020	NL3	46.1	12	25.4	6.6	1.6	0.3	0.2	26.0	55.1	13.3	2.5	1.7	0.4	600	762	132	16	0	0	1510	32.8
2020	LP2	39.6	8.4	16.9	10	3.7	0.3	0.3	21.2	42.7	25.3	9.3	0.8	0.8	420	507	200	37	0	0	1164	29.4
2020	RD1	107.9	14	57.8	30	5.4	0.4	0.2	13.1	53.6	27.8	5.0	0.4	0.2	705	1734	600	54	0	0	3093	28.7
2020	SD3	43.1	5	23.3	10.6	3	0.8	0.4	11.6	54.1	24.6	7.0	1.9	0.9	250	699	212	30	0	0	1191	27.6
	Total:	**319.2**						**Avg.=**	**17.3**	**50.5**	**52.0**	**10.8**	**9.9**	**1.1**	**Overall Field Area Average(bu/ac):**							**28.9**
2019	SD	69.7	7.8	5.2	7	11.9	21.7	16.1	11.2	7.5	10.0	17.1	31.1	23.1	390	156	140	119	0	0	805	11.5
2019	LP	68.7	15	6.7	10.6	11.3	11.3	14.1	21.4	9.8	15.4	16.4	16.4	20.5	735	201	212	113	0	0	1261	18.4
	Total:	**138.4**						**Avg.=**	**16.3**	**8.6**	**12.7**	**16.8**	**23.8**	**21.8**	**Overall Field Area Average(bu/ac):**							**15.0**

*Potential improvement calculated to second highest yield range recorded for the field.

Yield ranges not adjusted for machine stops , swath width variance.

Table 5: Grain Corn In-field Potential Yield Improvement for Field Area

															POTENTIAL IMPROVEMENT*							
			Area x Yield Range (bu)						% of Field Area						(bu)						Total	Per Ac
Farm	Field	Area	<80	80-100	100-120	120-140	140-160	>160	<80	80-100	100-120	120-140	140-160	>160	30	60	40	20	0	0		
2020	LP1	46.0	8.0	6.5	10.3	14.5	6	0.7	17.4	14.1	22.4	31.5	13.0	1.5	240	390	412	290	0	0	1332	29.0
2020	MS2	50.5	15.0	19.7	11.9	3.4	0.5	0	29.7	39.0	23.6	6.7	1.0	0.0	450	1182	476	68	0	0	2176	43.1
2020	MS4	35.8	8.9	12.9	9.5	3.8	0.6	0.1	24.9	36.0	26.5	10.6	1.7	0.3	267	774	380	76	0	0	1497	41.8
	Total:	132.3						**Avg.=**	24.0	29.7	24.2	16.3	5.2	0.6	**Overall Field Area Average(bu/ac):**							38.0
2019	BP1	42.4	41.0	1.4	0	0	0	0	96.7	3.3	0.0	0.0	0.0	0.0	1230	84	0	0	0	0	1314	31.0
2019	BP3	51.6	28.5	15	7.2	0.9	0	0	55.2	29.1	14.0	1.7	0.0	0.0	855	900	288	18	0	0	2061	39.9
2019	CS1	35.2	1.6	5	10.8	7.2	7.7	2.9	4.5	14.2	30.7	20.5	21.9	8.2	48	300	432	144	0	0	924	26.3
2019	CS4	58.4	21.3	28.7	8	0.2	0.1	0.1	36.5	49.1	13.7	0.3	0.2	0.2	639	1722	320	4	0	0	2685	46.0
	Total:	**187.6**						**Avg.=**	**48.2**	**23.9**	**14.6**	**5.6**	**5.5**	**2.1**	**Overall Field Area Average(bu/ac):**							**35.8**

*Potential improvement calculated to second highest yield range recorded for the field.
Lowest yield range potential improvement adjusted by 1/2 for uncropped areas,swath width variance.
Higher yield ranges not adjusted for machine stops , swath width variance.

Table 6: Russet Burbank In-field Potential Yield Improvement for Field Area

															POTENTIAL IMPROVEMENT*							
			Area x Yield Range (cwt)						% of Field Area						(cwt)						Total	Per Ac
Farm	Field	Area	< 150	>150	>200	>250	>300	>350	< 150	>150	>200	>250	>300	>350	200	150	100	50	0	0		
2020	BP4	31.5	5.7	5.1	9.6	7.9	2.2	1	18.1	16.2	30.5	25.1	7.0	3.2	1140	765	960	395	0	0	3260	103
2020	DE6	19.4	2.8	2.8	6.9	4.9	1.3	0.7	14.4	14.4	35.6	25.3	6.7	3.6	560	420	690	245	0	0	1915	99
2020	FB1	63.7	10.8	12.3	25.3	11.8	2.4	1.1	17.0	19.3	39.7	18.5	3.8	1.7	2160	1845	2530	590	0	0	7125	112
2020	NG3	39.9	4.8	3.6	12.8	13.4	3.8	1.5	12.0	9.0	32.1	33.6	9.5	3.8	960	540	1280	670	0	0	3450	86
	Total	**155**						**Avg.=**	**15.4**	**14.7**	**34.5**	**25.6**	**6.7**	**3.1**	**Overall Field Area Average(cwt/ac):**							**100.1**

*Potential improvement calculated to second highest yield range recorded for all fields.
Yield ranges not adjusted for machine stops.

Table 7: % Area for In-field Potential Yield Improvement for All Crops								
2019 Crop	Total Area		% of Field Area with Yield Improvement Potential					
			Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
Grain Corn	818		33	24	15	11	7	10
Oat	138		16	9	13	17	24	22
Soybean	339		8	32	36	16	6	2
Corn Silage	215		0	5	36	40	18	1
Forage	408		21	25	22	12	5	15
All Crops:	**1918**	**Average=**	**16**	**19**	**25**	**19**	**12**	**10**
		Total Area with Improvement Potential =				**80%**		
			Area with Limited Improvement Potential=					**20%**
2020 Crop	Total Area		% of Field Area with Yield Improvement Potential					
Grain Corn	132		24.0	29.7	24.2	16.3	5.2	0.6
Oat	319		17.3	50.5	52.0	10.8	9.9	1.1
Soybean	349		2.7	29.5	42.0	17.1	3.7	1.5
Corn Silage	143		0.3	7.0	42.5	45.4	4.4	0.3
Forage	144		16.8	16.6	16.6	16.6	16.6	16.8
Potato	155		15.4	14.7	34.5	25.6	6.7	3.1
All Crops:	**1242**	**Average=**	**12.8**	**24.7**	**35.3**	**22.0**	**7.8**	**3.9**
		Total Area with Improvement Potential =				**95%**		
			Area with Limited Improvement Potential=					**5%**

New Brunswick Soil & Crop Improvement Association Inc.
2-150 Woodside Lane Fredericton, NB E3C 2R9
el: 506-454-1736 Fax: 506-453-1985 www.nbscia.ca

CANADIAN AGRICULTURAL PARTNERSHIP

Georeferenced soil sampling was undertaken for the first time in south eastern New Brunswick. NBSCIA coordinators undertook hectare grid sampling and prepared the maps using the in-house SMS software on four farms covering approximately 130 acres. McCain Fertilizer completed SoilOptix® scanning over 209 acres on four farms. This initial data set encompassing 340 acres should be expanded to better define the in-field variability of common soil fertility elements impacting crop yield in this region.

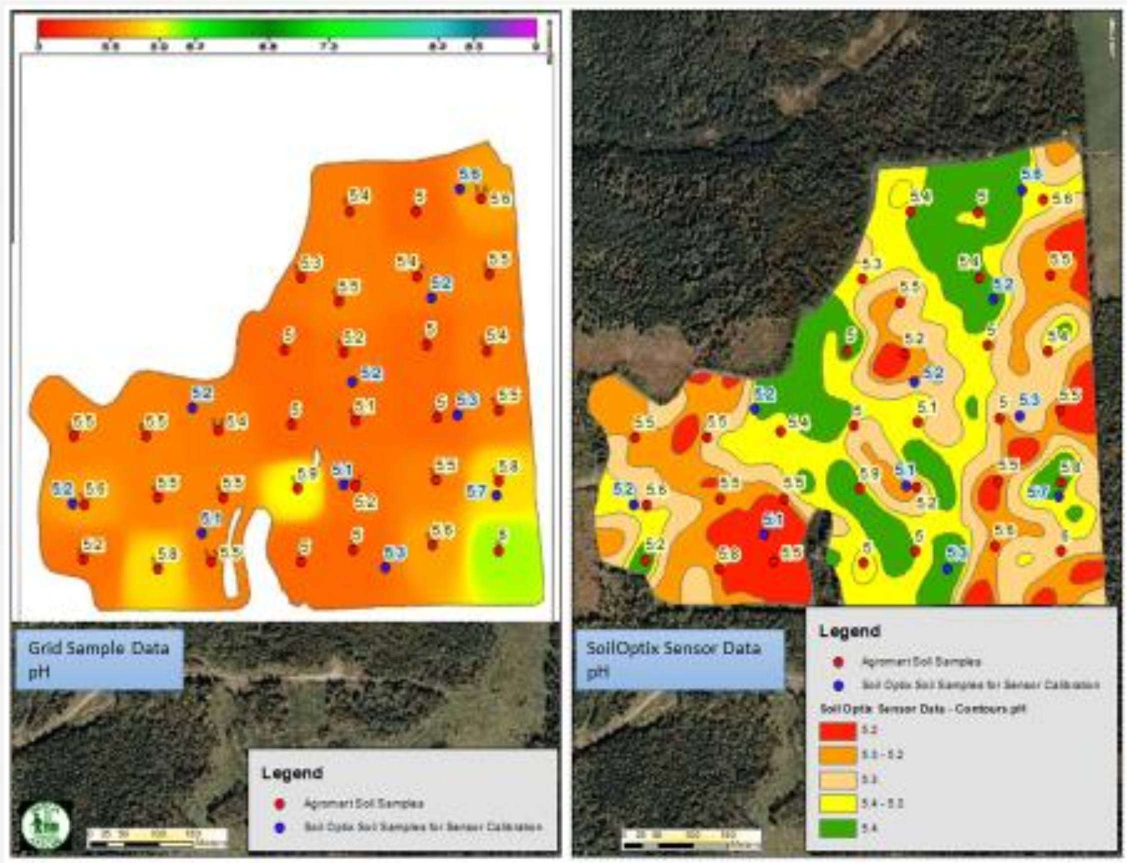
The SoilOptix® gamma-ray sensor measures Caesium-137, Uranium-238, Thorium-232, and Potassium-40. The resulting values are then extrapolated to 335 sample points per acre as illustrated below, compared to hectare grid sampling.

Figure 1 below illustrates the geo-referenced point values for soil pH compared to contour values using inverse distance interpolation. For comparison the average value of selected soil parameters from physical samples collected in all fields in 2019 are presented in Table 1 below. The significant difference in K level reported for Farm 3 is attributed to a fertilizer application between sample dates for the two methods.

TABLE 1: AVERAGE VALUE OF ALL POINT SAMPLES ANALYZED

	Hectare Grid				SoilOptix			
Farm	OM (%)	pH	CEC	K (ppm)	OM (%)	pH	CEC	K (ppm)
1	8.0	5.4	17.3	100	8.8	5.3	15.7	102
2	4.4	6.1	9.0	291	4.3	5.8	9.1	216
3	6.7	5.9	13.1	237	6.4	5.1	15.8	110
4	4.8	6.4	9.8	163	4.8	6.2	12.8	183
5	4.9	5.9	12.9	196	4.8	5.7	15.3	196

Figure 1: Geo-referenced point value for soil pH compared to the contour value.



In addition to the typical soil chemical attributes the SoilOptix® system provides an estimate of sand, silt, clay, water availability and water infiltration. Using sand, silt, and clay values a methodology was developed by AgTech GIS with the AgLeader SMS software to interpolate surface texture maps based on the USDA soil textural classification triangle. Texture maps were created for nineteen fields as presented in Appendix Illustration 3 attached.

The SMS software has a statistical function to provide correlation analysis between any georeferenced parameters reported (Appendix Illustration 4) which is a powerful tool for making production management decisions.

Conclusions:

Significant opportunity for yield improvement within a field for all crops reported exists. The quality of the yield data recorded is highly dependent on the operator's ability to manage swath width settings and calibration of the yield monitor and related sensors.

As reported previously the SoilOptix® method of soil status quantification provides a higher resolution of soil properties than the traditional hectare grid sampling method. SoilOptix® also provides additional characterization of soil type which is a significant component of soil health assessment. With research SoilOptix® data may be correlated to other soil health criteria such as carbon.

Sample grids can be created by the SMS operator to fit each field, then shared with each coordinator for georeferenced collection. This will allow each coordinator to collect grid soil samples without major GIS or GPS training.

Georeferenced or grid sampling will have an important role as the foundation for any new data sets collected for members. The NBSCIA coordinators will need to work with members to ensure sites are of a minimum reasonable size and fields are named properly and consistently.

Farmers and industry service providers need an improved understanding of the analytical and interpolation methods used to create the various status and application maps presented. This is particularly critical when attempting to compare correlate of geo-referenced sampling results to crop yield.

The project generated a large amount of data which has only been partially analyzed. Further analysis by agronomists and GIS specialists will identify factors to potentially improve profitability, competitiveness and sustainability of crop production in New Brunswick.

9. *Required next steps*.

Through this project activity NBSCIA is accumulating a significant amount of georeferenced soil status and crop yield information, ongoing analysis by agronomists and GIS specialists is required to better define analytical procedures for interpretation.

Future years of yield information from the subject fields should be collected and incorporated with lime and fertilizer application maps to study the magnitude of improvement and potential for long term sustainability.

Georeferenced soil sampling should be continued in the southern and north eastern Regions of the Province to accelerate the adoption and support utilization of commercially available crop production management technology or Precision Farming tools for crop management in New Brunswick.

Going forward building a solid Provincial GIS database of field status will be essential. Becoming more familiar with the mapping programs and compiling data will be the goal for NBSCIA Coordinators. The overall deliverables will only improve as more data is collected and mapped.

Examples such as 3D yield maps, 3D elevation maps with soil drainage and runoff mapping, swath by swath analysis for research work, and yield compared to soil properties are common for the Potato Belt. However, in other regions of the Province this is very advanced analysis for the NBSCIA members and non-members.

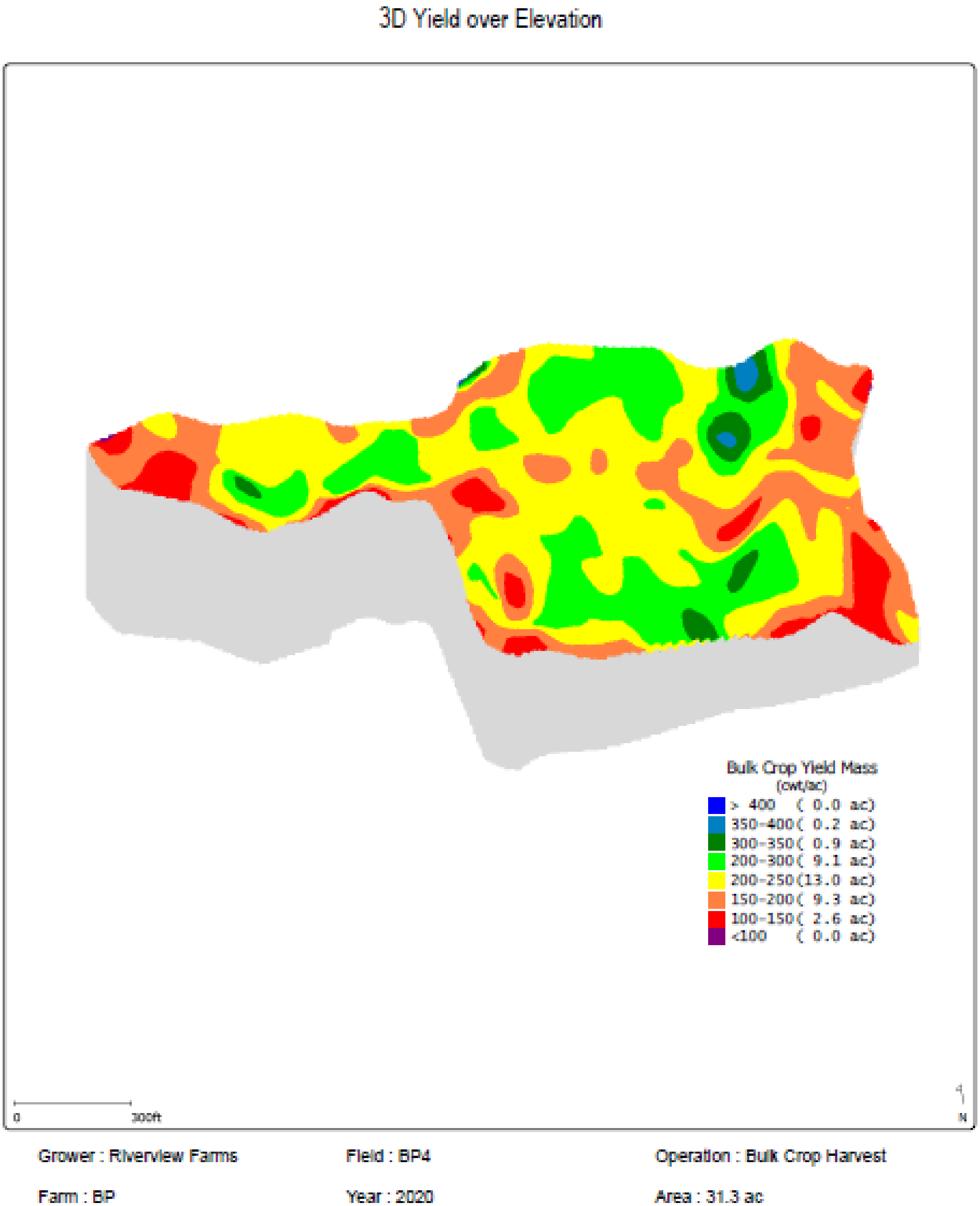
Farms that adopt the technology early will greatly benefit from having multiple years of data. This will allow the NBSCIA to more accurately investigate soil properties and yield dynamics on a field by field basis.

10. *Communication:*

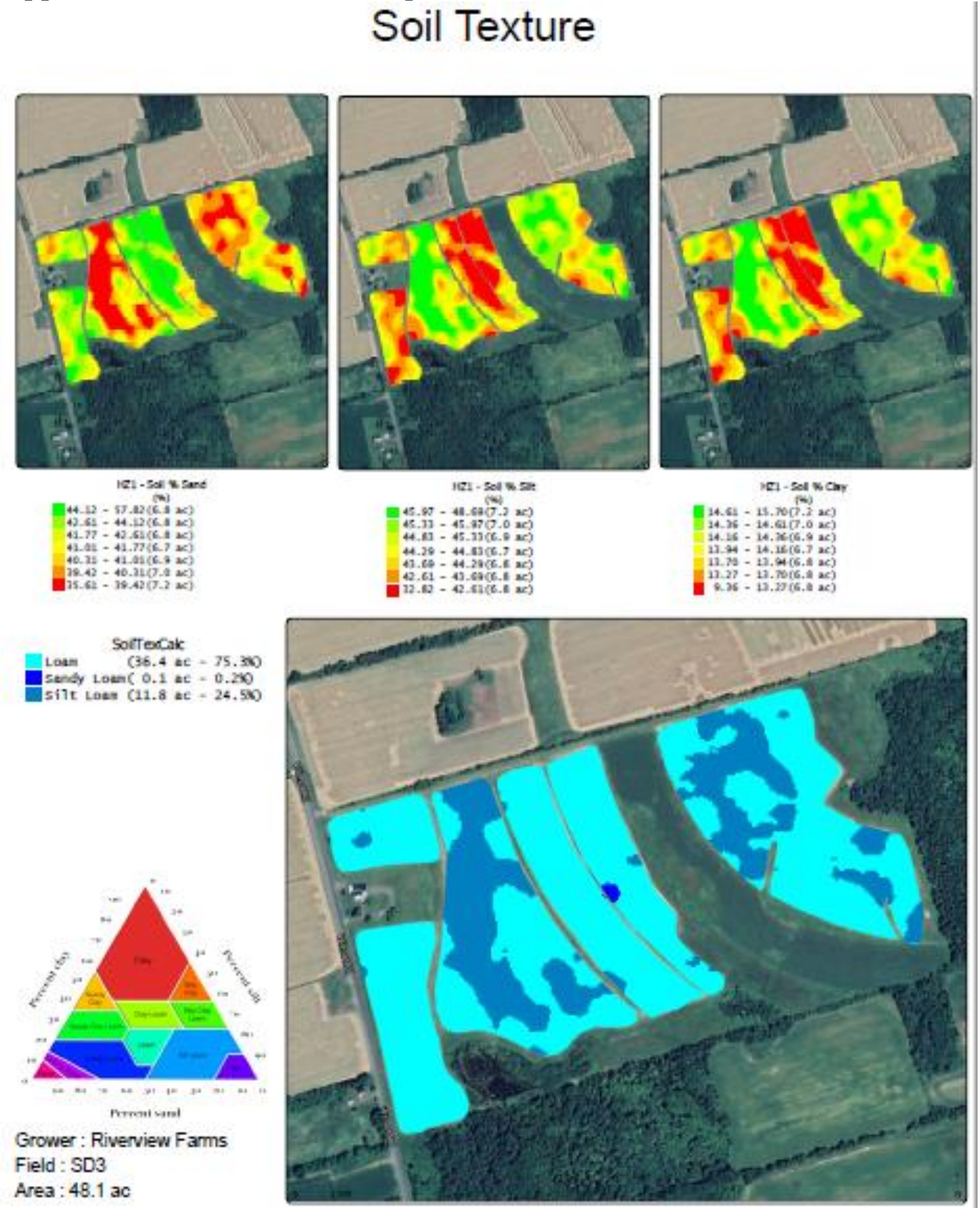
Interim reports will be provided throughout the project period. The information generated by this project will be available in the annual report of the NBSCIA and was presented at various provincial and local meetings as requested.

Appendix Illustration 1: 2D Potato Yield

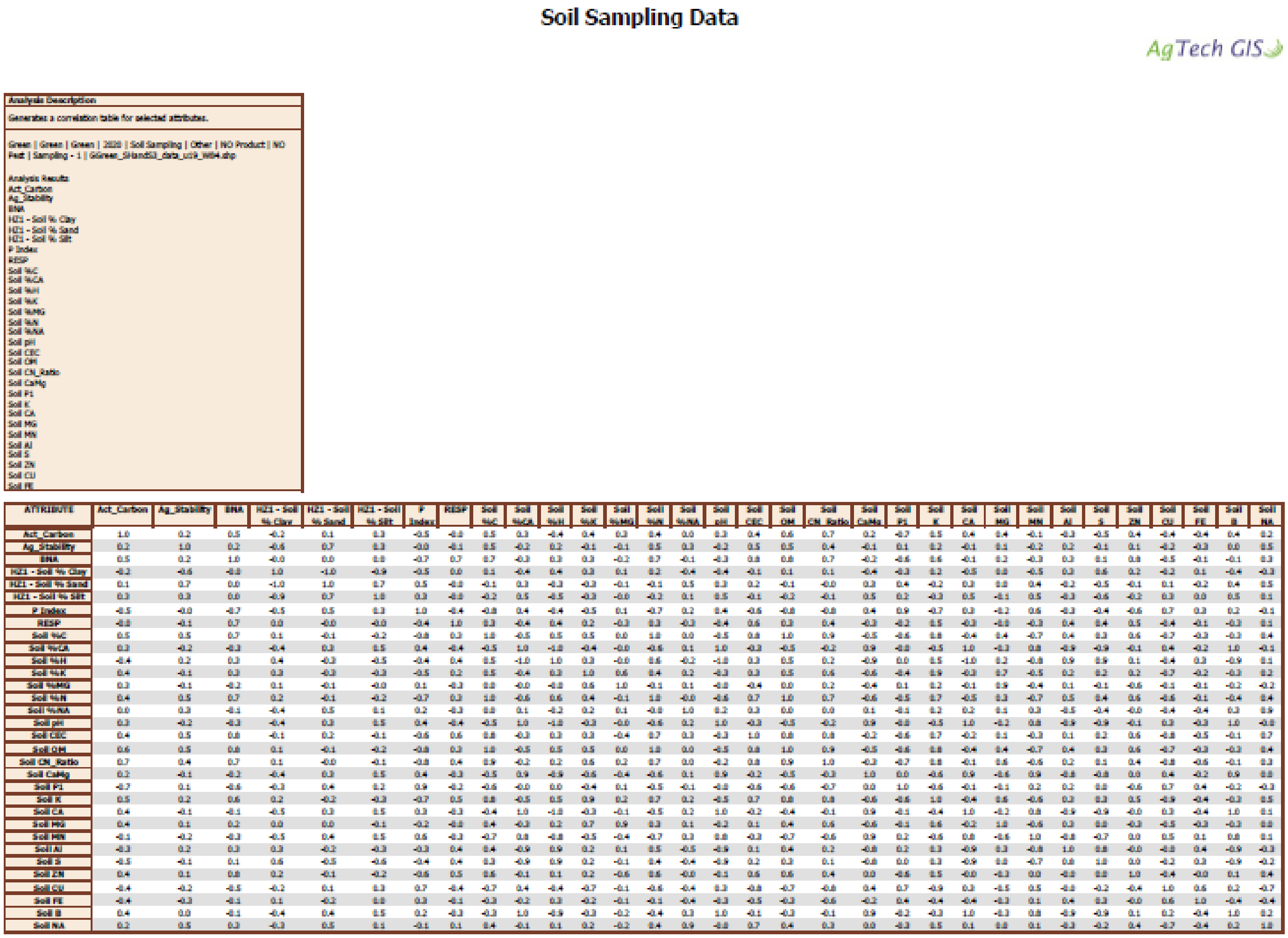
Appendix Illustration 2: 3 D Potato Yield



Appendix Illustration 3: SoilOptix® Soil Texture Classification from SMS



Appendix Illustration 4: SMS Correlation Analysis



Soil Sampling Data

AgTech GIS

Analysis Description

Generates a correlation table for selected attributes.

Green | Green | Green | 2020 | Soil Sampling | Other | NO Product | NO Pest | Sampling - 1 | GGreen_SHand53_data_u19_W84.shp

Analysis Results
Act_Carbon
Ag_Stability
BNA
HZ1 - Soil % Clay
HZ1 - Soil % Sand
HZ1 - Soil % Silt
P Index
RESP
Soil %C
Soil %CA
Soil %H
Soil %K
Soil %MG
Soil %N
Soil %NA
Soil pH
Soil CEC
Soil OM
Soil CN_Ratio
Soil CaMg
Soil P1
Soil K
Soil CA
Soil MG
Soil MN
Soil Al
Soil S
Soil ZN
Soil CU
Soil FE

ATTRIBUTE	Act_Carbc	Ag_Stabili	BNA	HZ1 - Soil % Clay	HZ1 - Soil % Sand	HZ1 - Soil % Silt	P Index	RESP	Soil %C	Soil %CA	Soil %H	Soil %K	Soil %MG	Soil %N	Soil %NA	Soil pH	Soil CEC	Soil OM
Act_Carbon	1	0.2	0.5	-0.2	0.1	0.3	-0.5	0	0.5	0.3	-0.4	0.4	0.3	0.4	0	0.3	0.4	0.6
Ag_Stability	0.2	1	0.2	-0.6	0.7	0.3	0	-0.1	0.5	-0.2	0.2	-0.1	-0.1	0.5	0.3	-0.2	0.5	0.5
BNA	0.5	0.2	1	0	0	0	-0.7	0.7	0.7	-0.3	0.3	0.3	-0.2	0.7	-0.1	-0.3	0.8	0.8
HZ1 - Soil % Clay	-0.2	-0.6	0	1	-1	-0.9	-0.5	0	0.1	-0.4	0.4	0.3	0.1	0.2	-0.4	-0.4	-0.1	0.1
HZ1 - Soil % Sand	0.1	0.7	0	-1	1	0.7	0.5	0	-0.1	0.3	-0.3	-0.3	-0.1	-0.1	0.5	0.3	0.2	-0.1
HZ1 - Soil % Silt	0.3	0.3	0	-0.9	0.7	1	0.3	0	-0.2	0.5	-0.5	-0.3	0	-0.2	0.1	0.5	-0.1	-0.2
P Index	-0.5	0	-0.7	-0.5	0.5	0.3	1	-0.4	-0.8	0.4	-0.4	-0.5	0.1	-0.7	0.2	0.4	-0.6	-0.8
RESP	0	-0.1	0.7	0	0	0	-0.4	1	0.3	-0.4	0.4	0.2	-0.3	0.3	-0.3	-0.4	0.6	0.3
Soil %C	0.5	0.5	0.7	0.1	-0.1	-0.2	-0.8	0.3	1	-0.5	0.5	0.5	0	1	0	-0.5	0.8	1
Soil %CA	0.3	-0.2	-0.3	-0.4	0.3	0.5	0.4	-0.4	-0.5	1	-1	-0.4	0	-0.6	0.1	1	-0.3	-0.5
Soil %H	-0.4	0.2	0.3	0.4	-0.3	-0.5	-0.4	0.4	0.5	-1	1	0.3	0	0.6	-0.2	-1	0.3	0.5
Soil %K	0.4	-0.1	0.3	0.3	-0.3	-0.3	-0.5	0.2	0.5	-0.4	0.3	1	0.6	0.4	0.2	-0.3	0.3	0.5
Soil %MG	0.3	-0.1	-0.2	0.1	-0.1	0	0.1	-0.3	0	0	0	0.6	1	-0.1	0.1	0	-0.4	0
Soil %N	0.4	0.5	0.7	0.2	-0.1	-0.2	-0.7	0.3	1	-0.6	0.6	0.4	-0.1	1	0	-0.6	0.7	1
Soil %NA	0	0.3	-0.1	-0.4	0.5	0.1	0.2	-0.3	0	0.1	-0.2	0.2	0.1	0	1	0.2	0.3	0
Soil pH	0.3	-0.2	-0.3	-0.4	0.3	0.5	0.4	-0.4	-0.5	1	-1	-0.3	0	-0.6	0.2	1	-0.3	-0.5
Soil CEC	0.4	0.5	0.8	-0.1	0.2	-0.1	-0.6	0.6	0.8	-0.3	0.3	0.3	-0.4	0.7	0.3	-0.3	1	0.8
Soil OM	0.6	0.5	0.8	0.1	-0.1	-0.2	-0.8	0.3	1	-0.5	0.5	0.5	0	1	0	-0.5	0.8	1