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CANADIAN AGRICULTURAL PARTNERSHIP

C1920-0035-Y3 N.B. Crop Production Optimization

Maximum economic yield 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 environ-mental and economic sustainability has never been greater.
N.B. farmers with the support of government programming have made considerable investments in hardware compo-nents associated with precision farming technology, particularly for guidance, auto-steering and yield monitoring. How-ever, exploiting the data collected is limited by the availability of local expertise from input suppliers or independent consultants to prepare the analysis and interpret the “digital agronomy.”

Objectives

• 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.
• To improve the knowledge and understanding of georeferenced data management and interpretation for the agri-cultural stakeholder community (producers, government specialists and service providers).
• To quantify the potential yield improvement for forages, grains, oilseeds and potatoes.
• To identify primary soil chemical and physical characteristics limiting crop yield that may contribute to in-field yield variability.
• To document the crop yield improvement or cost-benefit of implementing variable rate application of lime and fertilizer inputs over time.

Crop yield data for 2021 was provided by 11 producers for nine crop types over approximately 4,200 acres. The potential for in-field yield improvement varied between the crop types reported. However, over the total crop area, the average in-field yield improvement potential for all crop species was approximately 66 per cent compared to 89 per cent of the field area in 2020.

Conclusion

Significant opportunity exists for yield improvement within all crops. The quality of the yield data is highly dependent on the operator’s ability to managed swath width settings and calibration of the yield monitor and related sensors.
SoilOptix® soil status quantification provides a higher res-olution of soil properties than the traditional hectare grid sampling method. It also provides additional characteriza-tion 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. This could serve as a valuable tool in upcoming Agriculture Cli-mate Solution projects in New Brunswick.
Georeferenced or grid sampling will have an important role as the foundation for any new data sets collected for mem-bers. 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 under-standing of the analytical and interpolation methods used to create the various status and application maps presented. This is particularly critical when attempting to compare correlation of geo-referenced sampling results with to crop yield.
The project continues to generate a large amount of data which has only been partially analyzed. Further analysis by agronomists and GIS specialists will identify factors to po-tentially improve profitability, competitiveness and sustain-ability of crop production in New Brunswick.

Next steps
Geo-referenced soil sampling should continue in the south-ern and north eastern regions of the province to accelerate the adoption and support use of crop production manage-ment technology or precision farming tools.
Build a solid provincial GIS database of field status and soil health. Becoming more familiar with the mapping pro-grams and compiling data will be the goal for NBSCIA coordinators. The overall deliverables will only improve as more data is collected and mapped and stakeholder become familiar with the software.

C1920-0035-Y3 Optimisation De La Production Végétale au N.B.

Un rendement économique maximal pour toute culture est essentiel pour la rentabilité de l'acteur de l'industrie agricole impliqué dans la production végétale. Le développement récent des moniteurs de rendement montés sur moissonneuse-batteuse (fourrage et pommes de terre) a rendu la collecte de données géoréférencées sur le rendement des cultures facilement accessible au Nouveau-Brunswick. Lorsqu'elle est combinée à une analyse des sols géoréférencée et à une technologie d'application à débit variable, la capacité d'optimiser la production végétale pour la durabilité environnementale et économique n'a jamais été aussi grande.
Les agriculteurs du N.-B., avec l'appui des programmes gouvernementaux, ont fait des investissements considérables dans les composants matériels associés à la technologie de l'agriculture de précision, en particulier pour le guidage, la direction automatique et la surveillance du rendement. Cependant, l'exploitation des données collectées est limitée par la disponibilité de l'expertise locale des fournisseurs d'intrants ou des consultants indépendants pour préparer l'analyse et interpréter l "“agronomie numérique".”

Objectifs
* Accélérer l'adoption et l'utilisation de technologies de gestion de la production agricole disponibles dans le commerce ou d'outils d'agriculture de précision pour la gestion des cultures fourragères, céréalières, de maïs, de soja et de pommes de terre.
* Améliorer la connaissance et la compréhension de la gestion et de l'interprétation des données géoréférencées pour la communauté des intervenants agricoles (producteurs, spécialistes gouvernementaux et prestataires de services).
* Quantifier l'amélioration potentielle du rendement pour les fourrages, les céréales, les oléagineux et les pommes de terre.
* Identifier les principales caractéristiques chimiques et physiques du sol limitant le rendement des cultures qui peuvent contribuer à la variabilité du rendement au champ.
* Documenter l'amélioration du rendement des cultures ou le rapport coût-bénéfice de la mise en oeuvre de l'application à taux variable d'intrants de chaux et d'engrais au fil du temps.

Les données sur le rendement des cultures pour 2021 ont été fournies par 11 producteurs pour neuf types de cultures sur environ 4 200 acres. Le potentiel d'amélioration du rendement au champ variait selon les types de cultures signalés. Cependant, sur l'ensemble de la superficie cultivée, le potentiel moyen d'amélioration du rendement au champ pour toutes les espèces de cultures était d'environ 66%, contre 89% de la superficie des champs en 2020.

Conclusion

Il existe d'importantes possibilités d'amélioration du rendement de toutes les cultures. La qualité des données de rendement dépend fortement de la capacité de l'opérateur à gérer les paramètres de largeur d'andain et l'étalonnage du moni-teur de rendement et des capteurs associés.

La quantification de l'état du sol SoilOptix ® fournit une résolution plus élevée des propriétés du sol que la méthode traditionnelle d'échantillonnage par grille d'hectare. Il fournit également une caractérisation supplémentaire du type de sol, qui est un élément important de l'évaluation de la santé du sol. Avec la recherche, les données de SoilOptix ® peuvent être corrélées à d'autres critères de santé du sol tels que le carbone. Cela pourrait servir d'outil précieux dans les projets de solu-tions climatiques agricoles à venir au Nouveau-Brunswick.

L'échantillonnage géoréférencé ou quadrillé jouera un rôle important en tant que fondement de tout nouvel ensemble de données collectées pour les membres. Les coordonnateurs de la NBSCIA devront travailler avec les membres pour s'assurer que les sites sont d'une taille minimale raisonnable et que les champs sont nommés correctement et de manière cohérente.

Les agriculteurs et les fournisseurs de services de l'industrie ont besoin d'une meilleure compréhension des méthodes d'analyse et d'interpolation utilisées pour créer les différentes cartes de statut et d'application présentées. Ceci est particulièrement critique lorsque l'on tente de comparer la corrélation des résultats d'échantillonnage géoréférencés avec le rendement des cultures.

Le projet continue de générer une grande quantité de données qui n'ont été que partiellement analysées. Une analyse plus approfondie par des agronomes et des spécialistes des SIG identifiera les facteurs susceptibles d'améliorer la rentabilité, la compétitivité et la durabilité de la production végétale au Nouveau-Brunswick.

Prochaines étapes

L'échantillonnage géoréférencé des sols devrait se poursuivre dans les régions du sud et du nord-est de la province pour accélérer l'adoption et soutenir l'utilisation de la technologie de gestion de la production végétale ou des outils d'agriculture de précision.

Constituer une base de données SIG provinciale solide sur l'état des champs et la santé des sols. Se familiariser davan-tage avec les programmes de cartographie et la compilation des données sera l'objectif des coordonnateurs de la NBS-CIA. Les livrables globaux ne feront que s'améliorer à mesure que davantage de données seront collectées et cartogra-phiées et que les parties prenantes se familiariseront avec le logiciel.

Enabling Agricultural Research and Innovation

Element 1, Innovative Research and Development Interim Report

1. *Project title and project number*: NB Crop Production Optimization C1920-0035-Y3

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
   Ryan Callahan, McCain Fertilizers Ltd. SoilOptix field operations
   Shawn Paget, Riverview Farms Corporation, owner/operator – potato, soybean and grain corn yield data
   Chad Young, B&C Young Farms, owner/operator-wheat, oat, soybean, grain corn yield data
   Nick Tisdale, Lakefront Farms, owner/operator-oat yield data
   Ben Wohlgemouth, Greenleaf Harvesting, owner/operator - forage yield data

3. *Summary*.

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.

- 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 the annual report.
- Presentations of the yearly and composite results at producer, Local and NBSCIA meetings will be as requested basis. One to one consultation will be provided to project participants.

Crop yield data for 2021 was provided by eleven producers for nine crop types over approximately 4,200 acres. Forage and corn silage yield data was collected from seven farms using custom services by Greenleaf Harvesting. The remaining data was provided by producers' grain combine and potato yield monitors. All data was exported from the JD Operations Center and processed using AgLeader SMS software. and interpolated in 2D layouts.

The potential for in-field yield improvement varied between the crop types reported in 2021. However, over the total crop area of 4200 acres the average in-field yield improvement potential for all crop species was approximately 66% compared to 89% of the field area in 2020. Approximately 34% of the field area was considered to have a limited potential for yield improvement in 2021 compared to 11% in 2020. Much of this difference can be attributed to the exceptional growing conditions experienced during 2021 the 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 and climate change mitigation.

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 manage climate change by improving environmental sustainability 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 yield monitor. Grain combine and potato harvester yield monitors have been utilized in NB since 2000. The recent introduction of forage harvester yield monitors by a custom operator 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 soil health, fertility, elevation or slope can identify one or more particular influencing factors.

Geo-referenced (grid point) soil sampling at one hectare or less provides a cost-effective means of delineating soil characteristics within a field that can be adjusted with variable rate application of soil amendments. 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 and soil health attributes.
- 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 undertaken as requested. One to one consultation will be provided to project participants.

7. *Material and Methods*:

Crop yield data for 2021 was provided by eleven producers for nine crop types over approximately 4,200 acres. Forage and corn silage yield data was collected from seven farms using custom services by Greenleaf Harvesting. The remaining data was provided by producers with grain combine and potato yield monitors.

McCain Fertilizer provided geo-referenced fertility data using SoilOptix for approximately 580 acres with corresponding yield data. AgTech GIS exported the yield data from JD Operations center and prepared crop yield maps, soil textural classification using the USDA triangle in SMS from the SoilOptix® data collected and a correlation analysis of yield to soil parameters for the NBSCIA SMS database.

NBSCIA project leader f calculated the magnitude of crop yield improvement for the 2021 season with a comparison to the 2020 and 2019 crop seasons.

NBSCIA coordinators undertook hectare grid sampling and prepared the soil fertility maps using the in-house SMS software on six farms covering approximately 216 acres in the Kings and Moncton regions.

exp conducted geostatistical analysis, interpretation and provided ArcGIS support to NBSCIA Staff.

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*:

Public Health Guidelines enacted in the fall of 2021 to manage the spread COVID-19 impeded the ability of McCain Fertilizer staff to travel outside the specific health zone. Consequently, the window of opportunity to scan the blueberry area was lost.

Consistent field identification by the farm owners and machine operators in the JD operations center remains a significant issue for efficient data processing.

Yield maps were prepared for all crops and cooperators in all project fields and interpolated in 2D layouts as presented in previous interim reports.

Cooperators provided access to yield data for nine crop types. Summary tables were prepared for all cooperators for each crop for 2019, 2020 and 2021. These tables with the 2D yield maps will be provided to each cooperator and can be provided by request to the Project Leader.

The total area, yield range area, % of field area by yield range with the overall average potential in field yield improvement from all fields for all crop types for each year is presented in Table 1, below.

Across all years within field potential forage yield improvement was estimated to average 1.2 ton per acre.

Across all years within field potential corn silage yield improvement was estimated to average 2.9 ton per acre.

Across all years within field potential wheat yield improvement was estimated to average 26.7 bushels per acre.

Across all years within field potential wheat yield improvement was estimated to average 26.7 bushels per acre.

Across all years within field potential oat yield improvement was estimated to average 11.8 bushels per acre.

Across all years within field potential barley yield improvement was estimated to average 8.8 bushels per acre.

Across all years within field potential soybean yield improvement was estimated to average 23.8 bushels per acre.

Across all years within field potential grain corn yield improvement was estimated to average 27.7 bushels per acre.

Across all years within field potential potato yield improvement was estimated to average 90.6 cwts. per acre.

The 2021 within field potential yield improvement for corn cob meal and annual forage mixtures was estimated to average 1 ton per acre and .4 ton per acre, respectively.

2021 was an above average year for heat unit accumulation and nearly perfect rainfall throughout. It is interesting to note that the potential in-field yield improvement for corn and soybean were significantly reduced compared to the other crop types.

Georeferenced soil sampling was continued in south eastern New Brunswick. Soil maps for each cooperator were prepared as reported in previous interim project reports. The overall fertilizer efficiency improvement potential for a particular soil pH was calculated from the maps and reported in Table 3, below.

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Table 1: C1920-0035-Y3 NB Crop Production Optimization 2021 Report Summary Table

Table 1: Forage Potential Yield Improvement for Monitored Field Area

			Average Area x Yield Range (Tons)						Average % of Field Area x Yield Range (Tons)						POTENTIAL IMPROVEMENT* **(Ton/Ac.)**
Year	Field	Area(ac.)	< 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	
2019	Total	408	10.0	11.1	9.3	5.2	2.3	4.5	21.0	24.7	22.5	11.7	5.4	14.7	1.1
2020	Total	139	16.3	15.5	14.8	13.7	12.6	10.2	20.0	18.6	17.6	16.6	15.4	11.7	1.0
2021	Total	268	6.0	8.6	7.9	4.7	1.9	0.7	19.0	29.8	25.2	15.9	7.1	2.9	1.3

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

			Average Area x Yield Range (Tons)						Average % of Field Area x Yield Range (Tons)						POTENTIAL IMPROVEMENT* **(Ton/Ac.)**
Year	Field	Area(ac.)	< 4.0	4-6	6-8	8-10	10-12	>12	< 4.0	4-6	6-8	8-10	10-12	>12	
2018	Total	63	0.0	0.5	17.5	44.1	1.3	0.0	0.0	0.8	27.6	69.6	2.1	0.0	2.5
2019	Total	139	0.2	2.9	12.7	36.1	17.2	0.8	0.2	3.9	17.5	50.8	26.4	1.2	2.0
2020	Total	143	0.2	2.1	14.5	17.4	1.4	0.2	0.3	7.0	42.5	45.4	4.4	0.3	3.0
2021	Total	311	6.9	6.0	8.0	2.5	0.3	0.1	32.7	25.1	29.5	10.9	1.2	0.6	3.9

Table 3: Wheat In-field Potential Yield Improvement for Monitored Field Area

			Average Area x Yield Range (bu)						Average % of Field Area x Yield Range (bu)						POTENTIAL IMPROVEMENT* **(Bu./Ac.)**
Year	Field	Area(ac.)	<40	40-55	55-70	70-85	85-100	>100	< 20	20-30	30-40	40-50	50-60	>60	
2019	Total	121	3.7	14.9	27.6	12.4	1.6	0.1	5.6	20.6	40.6	26.9	5.7	0.6	25.6
2020	Total	118	29.2	9.1	1.0	0.1	0.0	0.1	69.0	27.6	2.9	0.3	0.0	0.2	25.7
2021	Total	616	8.3	12.8	14.0	8.2	0.5	0.1	28.6	31.5	24.8	13.7	0.9	0.3	27.8

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

Year	Field	Area(ac.)	Average Area x Yield Range (bu) <75	95-105	105-115	115-125	125-135	>135	Average % of Field Area x Yield Range (bu) <75	95-105	105-115	115-125	125-135	>135	POTENTIAL IMPROVEMENT* **(Bu./Ac.)**
2019	Total:	138	11.3	6.0	8.8	11.6	16.5	15.1	16.3	8.6	12.7	16.8	23.8	21.8	10.9
2020	Total:	492	10.5	25.7	14.6	5.0	1.7	4.0	16.7	42.7	21.8	8.4	3.0	7.3	22.2
2021	Total:	65	0.8	0.6	2.2	8.5	22.7	30.7	1.2	0.9	3.4	13.0	34.7	46.9	2.5

Table 5: Barley In-field Potential Yield Improvement for Monitored Field Area

Year	Field	Area(ac.)	Average Area x Yield Range (bu) <60	60-65	65-70	70-75	75-80	>80	Average % of Field Area x Yield Range (bu) <60	60-65	65-70	70-75	75-80	>80	POTENTIAL IMPROVEMENT* **(Bu./Ac.)**
2019	Total:	222	31.7	15.9	15.9	15.9	15.9	15.9	28.6	14.3	14.3	14.3	14.3	14.3	9.3
2021	Total:	463	19.7	9.5	10.2	8.9	7.6	21.3	26.0	13.1	13.6	10.8	8.3	28.3	8.4

Table 6: Soybean In-field Potential Yield Improvement for Monitored Field Area

Year	Field	Area(ac.)	Average Area x Yield Range (bu) <20	20-30	30-40	40-50	50-60	>60	Average % of Field Area x Yield Range (bu) < 20	20-30	30-40	40-50	50-60	>60	POTENTIAL IMPROVEMENT* **(Bu./Ac.)**
2019	Total:	339	3.3	21.2	22.6	12.3	7.1	1.3	8.1	31.8	36.3	16.1	6.1	1.5	26.9
2020	Total:	349	2.2	14.3	21.9	8.6	2.1	0.8	2.7	22.2	47.6	20.9	4.9	1.6	28.2
2021	Total:	549	1.9	3.0	6.6	9.0	7.5	8.5	6.8	12.5	22.2	26.0	18.2	14.0	16.3

Table 7: Grain Corn In-field Potential Yield Improvement for Monitored Field Area

Year	Field	Area(ac.)	Average Area x Yield Range (bu) <80	80-100	100-120	120-140	140-160	>160	Average % of Field Area x Yield Range (bu) <80	80-100	100-120	120-140	140-160	>160	POTENTIAL IMPROVEMENT* **(Bu./Ac.)**
2019	Total:	818	22.7	14.8	13.4	16.3	7.2	7.5	32.8	23.8	15.3	11.0	7.2	9.9	32.5
2020	Total:	132	10.6	13.0	10.6	7.2	2.4	0.3	24.0	29.7	24.2	16.3	5.2	0.6	38.0
			<120	120-140	140-160	160-180	180-200	>200	<120	120-140	140-160	160-180	180-200	>200	
2021	Total:	1246	2.6	1.5	3.8	21.5	25.4	5.1	4.9	2.8	6.5	34.4	45.0	6.4	12.6

Table 6: Potato In-field Potential Yield Improvement for Monitored Field Area

			Average Area x Yield Range (cwt)						% of Field Area						POTENTIAL IMPROVEMENT* **(cwt./Ac.)**
Farm	Field	Area	< 150	>150	>200	>250	>300	>350	< 150	>150	>200	>250	>300	>350	
2020	Total	154.5	6	6.0	13.7	9.5	2.4	1.1	15.4	14.7	34.5	25.6	6.7	3.1	100.1
2021	Total	589	6.8	2.7	3.6	6.6	8.2	6.7	22.9	8.9	11.8	20.3	20.6	15.2	81.2

Table 9: 2021 Annual Forage Potential Yield Improvement for Monitored Field Area

			Average Area x Yield Range (Tons)						Average % of Field Area x Yield Range (Tons)						POTENTIAL IMPROVEMENT* **(Ton/Ac.)**
Year	Field	Area(ac.)	< 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	
Cob Meal	Total:	17	3.3	2.9	2.7	2.7	2.7	2.5	19.5	17.4	15.9	15.9	16.2	15.0	1.0
Peas+Grain	Total:	76	0.3	1.5	3.3	4.4	5.0	11.0	1.6	7.0	14.9	17.9	19.2	39.3	0.4

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

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

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The potential area for in-field yield improvement varied between the crop species and years as illustrated in Table 2, below. The overall area with potential improvement appears to correspond with the variability reported for each of the growing seasons.

Table 2: % 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	4	18	51	26	1
Forage	408		21	25	22	12	5	15
All Crops:	**1918**	**Average=**	**16**	**19**	**21**	**21**	**14**	**10**
		Total Area with Improvement Potential				**76**		
			Area with Limited Improvement Potential=					**24**
2020 Crop	Total Area		% of Field Area with Yield Improvement Potential					
			Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
Grain Corn	132		24	30	24	16	5	1
Oat	319		17	43	22	8	3	7
Soybean	349		3	22	48	21	5	2
Corn Silage	143		0	7	43	45	4	0
Forage	139		20	19	18	17	15	12
Potato	155		15	15	34	26	7	3
All Crops:	**1237**	**Average=**	**13**	**22**	**31**	**22**	**7**	**4**
		Total Area with Improvement Potential				**89%**		
			Area with Limited Improvement Potential=					**11%**
2021 Crop	Total Area		% of Field Area with Yield Improvement Potential					
			Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
Grain Corn	1246		5	3	7	34	45	6
Oat	65		1	1	3	13	35	47
Soybean	549		7	13	22	26	18	14
Corn Silage	311		33	25	30	11	1	1
Forage	268		19	30	25	16	7	3
Wheat	616		29	32	25	14	1	0
Barley	463		26	13	14	11	8	28
Annual Forage	76		2	7	15	18	19	39
CobMeal	17		20	17	16	16	16	15
Potato	589		23	9	12	20	21	15
All Crops:	**4200**	**Average=**	**16**	**15**	**17**	**18**	**17**	**17**
		Total Area with Improvement Potential				**66%**		
			Area with Limited Improvement Potential=					**34%**

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Table 3: Potential Fertilizer Efficiency Improvement by Field Area

															POTENTIAL OVERALL IMPROVEMENT*						
			pH Range x Field Area (ac.)						% of Field Area x pH Range						Field Area (ac.) x % Improvement						Total Area
Year	Field	Area	<4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5	>6.5	<4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5	>6.5	57%	40%	19%	6%	0%		
2020	Hayes	30.5	0	0	8.9	9.2	12.4	0	0.0	0.0	29.2	30.2	40.7	0.0	0.0	8.9	9.2	12.4	0		30.5
	Timber	77.6				14.4	51.2	12	0.0	0.0	0.0	18.6	66.0	15.5	0.0	0	14	51.2	12		77.6
	Walker	52.6				5.5	33.1	14	0.0	0.0	0.0	10.5	62.9	26.6	0.0	0	5.5	33.1	14		52.6
	Waddy	52.4					35.8	16.6	0.0	0.0	0.0	0.0	68.3	31.7	0.0	0	0	35.8	16.6		52.4
	Total	**213.1**						**Avg.=**	0	0	7	15	59	18	0	9	29	133	43	<sum>	213
2021	Miller	33.7	0	0	6	5.99	21.21	**0.52**	0.0	0.0	17.8	17.8	62.9	1.5	0.0	6	6	21.2	0.52		33.7
	Graham	12.0				0.17	6.15	5.66	0.0	0.0	0.0	1.4	51.3	47.2	0.0	0	0.2	6.15	5.66		12.0
	Van Der Brand	39.7				18.17	19.44	2.07	0.0	0.0	0.0	45.8	49.0	5.2	0.0	0	18	19.4	2.07		39.7
	Boss	45.2		5.57	32.25	6.14	1.24	0	0.0	12.3	71.3	13.6	2.7	0.0	5.6	32.3	6.1	1.24	0		45.2
	Estabroc	31.8		1.17	20.58	10.01		0	0.0	3.7	64.8	31.5	0.0	0.0	1.2	20.6	10	0	0		31.8
	Estabroc	24.5	0.93	2.85	8.43	12.28	0.05	0	3.8	11.6	34.4	50.0	0.2	0.0	2.9	8.43	12	0.05	0		23.6
	Helder	26.4				6.91	16.49	2.98	0.0	0.0	0.0	26.2	62.5	11.3	0.0	0	6.9	16.5	2.98		26.4
2021		**213.3**						**Avg.=**	0.5	3.9	26.9	26.6	32.7	9.3	9.6	67.3	59.7	64.6	11.2	<sum>	212.3

* Potential efficiency improvement calculated from Pub534-84 Atlantic Soils Need Lime ; Modified by Perennia December 2021.

Conclusions:

Significant opportunity for yield improvement within a filed for all crops reported exists. The quality of the yield data recorded is highly dependent on the operator's ability to managed 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. This could serve as a valuable tool in upcoming Agriculture Climate Solution projects in New Brunswick.

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 correlation of geo-referenced sampling results with to crop yield.

The project continues to generate 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 continually define analytical procedures for interpretation and inclusion in the upcoming Agriculture Climate Solutions projects in the Province.

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 yield improvement and potential for fertilizer efficiency improvement for long term sustainability and climate change mitigation.

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.

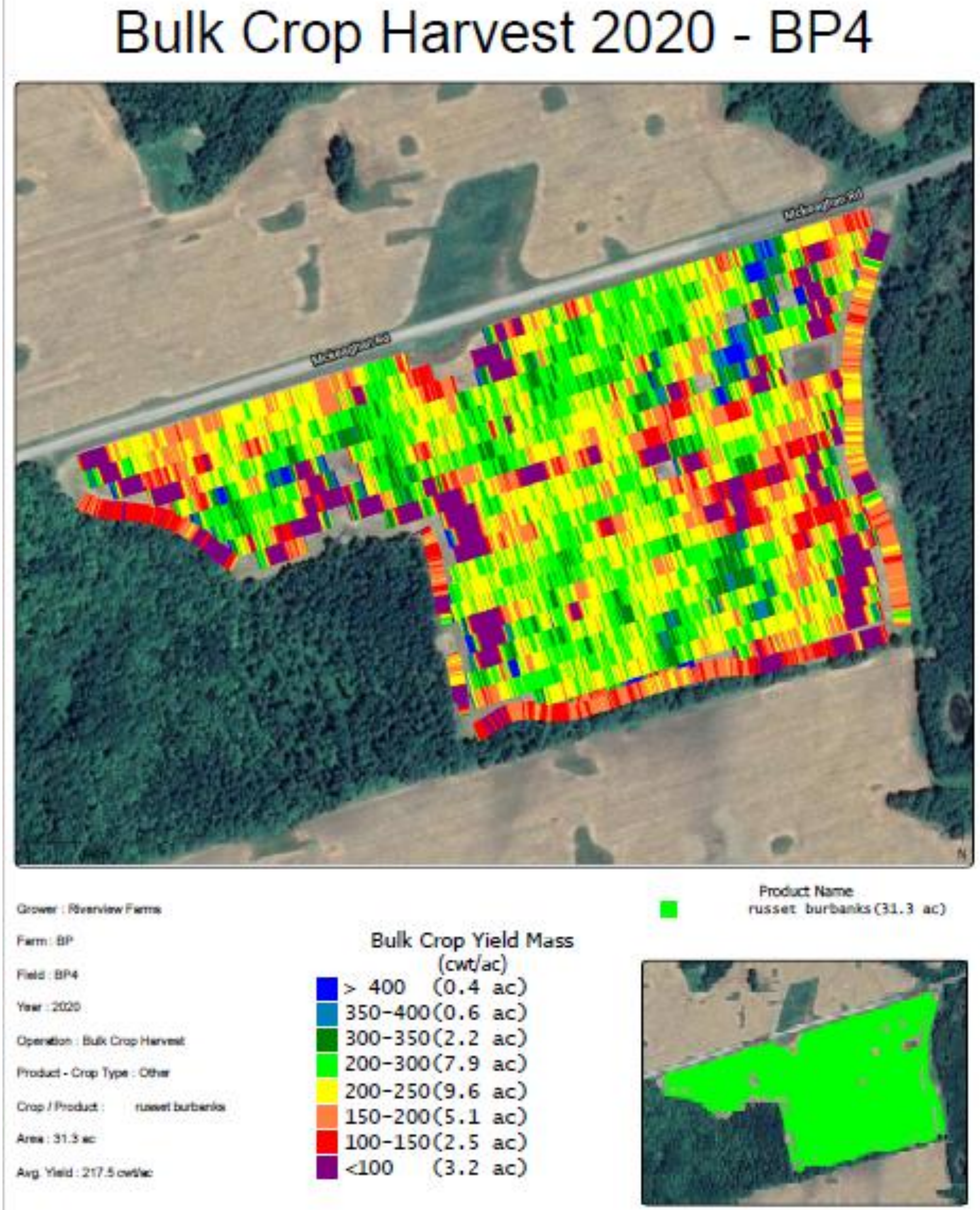
Going forward building a solid Provincial GIS database of field status and soil health will be essential. Becoming more familiar with the mapping programs and compiling data will be the goal for NBSCIA Coordinators. The overall deliverables will only improve as more data is collected and mapped and stakeholder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

Examples such as, 3D yield maps, 3D elevation maps with soil drainage and runoff mapping, swath by swath analysis for research work, and yield correlation analysis to soil properties, is readily available to producers in the Potato Belt. However, for 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 NBSCIA to more accurately investigate soil properties and yield dynamics on a field by field basis.

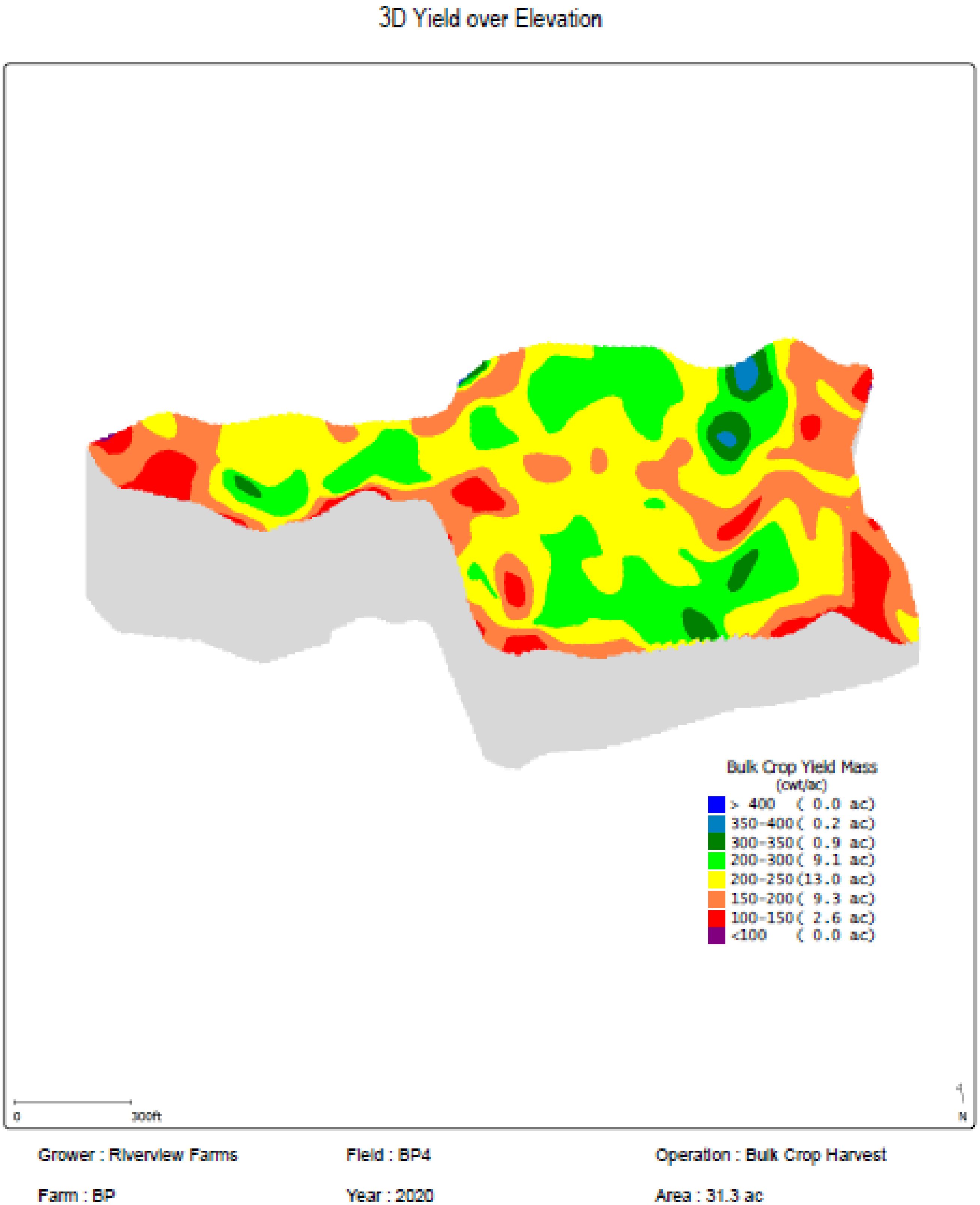
10. *Communication:*

Interim reports will be provide 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.

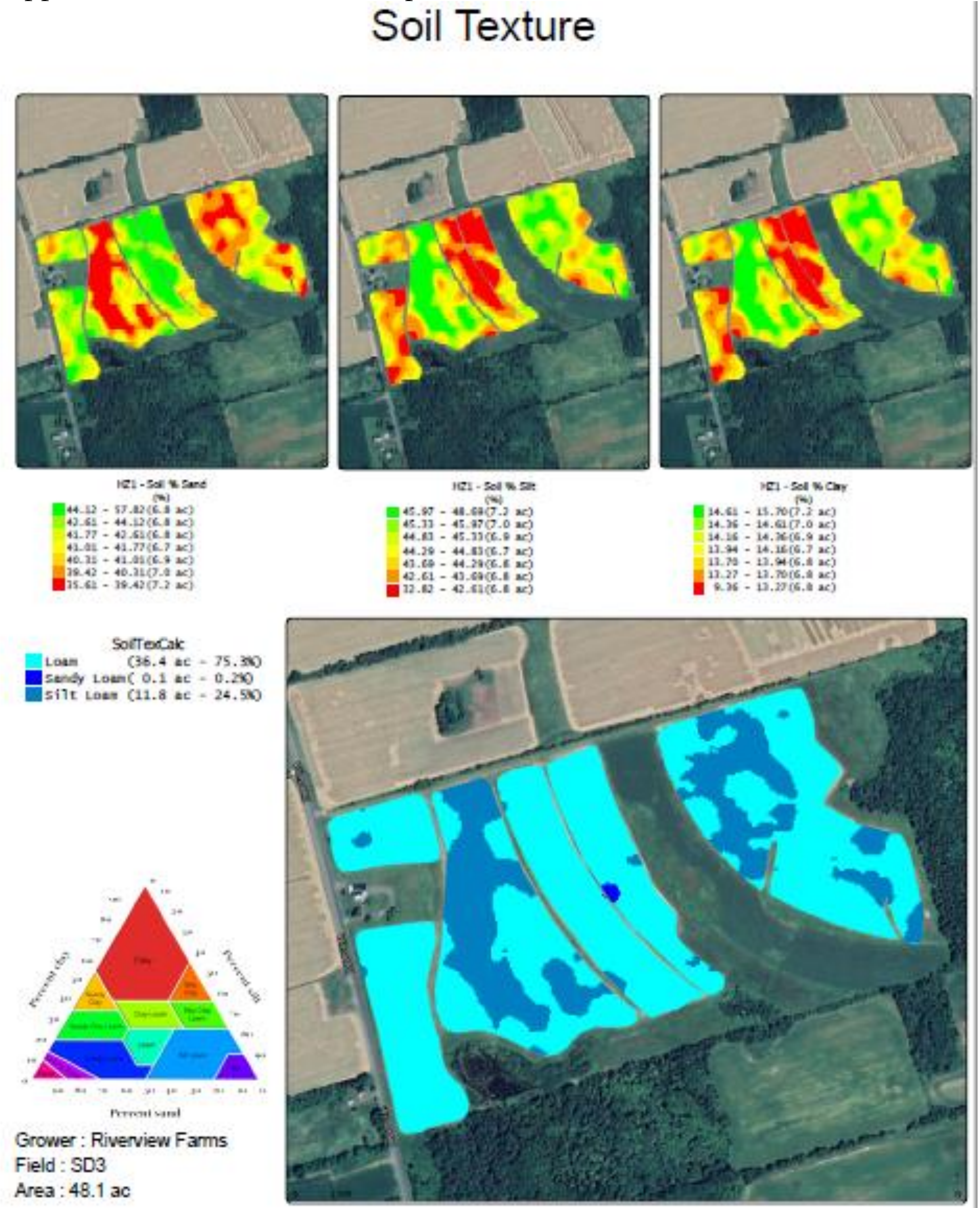
Appendix Illustration 1: 2D Potato Yield



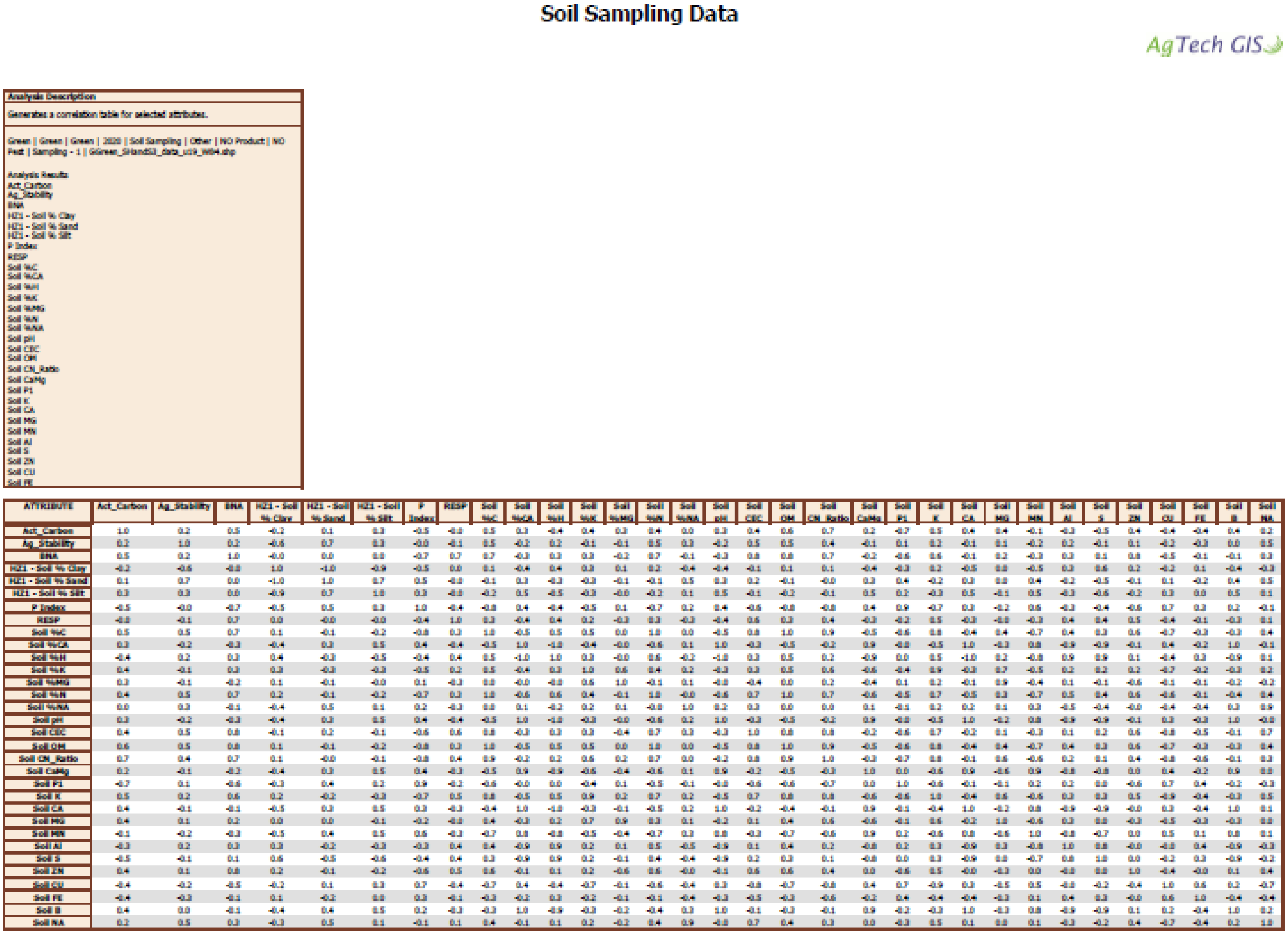
Appendix Illustration 2: 3 D Potato Yield



Appendix Illustration 3: SoilOptix® Soil Texture Classification from SMS



Appendix Illustration 4: SMS Correlation Analysis



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