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NB Crop Production Optimization C1920-0035-Y4

Objectives

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.

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 combine or harvester mounted yield monitor.

Crop yield data was provided by eleven producers for nine crop types over four crop years and approximately 14,000 acres. Forage and corn silage yield data was collected from seven farms using custom services by Greenleaf Harvesting. The remaining data was provided by producer's grain combine and potato yield monitors. All yield 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. However, over the total crop area of approximately 14,000 acres the average in-field yield improvement potential for all crop species was approximately 70%. Approximately 30% of the field area was considered to have a limited potential for yield improvement across the four years.

Forty-seven per cent of the total field area over three years was estimated to have a potential fertilizer efficiency improvement if the pH was increased to 6.0.

Overall, the correlation values for each crop species with soil characteristics were low (less than 0.4) either positive or negative indicating that no single soil attribute had a significant effect on crop yield.

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.

Conclusion

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 managed swath width settings and calibration of the yield monitor and related sensors.

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 crop yield.

This project activity 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.

Optimisation de la production des cultures au Nouveau-Brunswick - C1920-0035-Y4

Objectifs

1. Accélérer l'adoption et l'utilisation des technologies de gestion de la production des cultures disponibles sur le marché ou des outils d'agriculture de précision pour la gestion des cultures fourragères, céréalières, de maïs, de soja et de pommes de terre au Nouveau-Brunswick.
2. Améliorer la connaissance et la compréhension de la gestion et de l'interprétation des données géoréférencées au sein de la communauté des intervenants agricoles du Nouveau-Brunswick (producteurs, spécialistes gouvernementaux et fournisseurs de services).
3. Quantifier l'amélioration potentielle du rendement des fourrages, des céréales, des oléagineux et des pommes de terre au Nouveau-Brunswick.
4. Identifier les principales caractéristiques chimiques et physiques du sol qui limitent le rendement des cultures et qui peuvent contribuer à la variabilité du rendement dans les champs.
5. Documenter l'amélioration du rendement des cultures ou les coûts-avantages de l'application de taux variables de chaux et d'engrais au fil du temps.

Résumé

Un élément clé du mandat de l'AASCNB est de soutenir les exploitations agricoles avec des services de qualité et un leadership en matière de sensibilisation à l'environnement et de gestion de la production végétale, afin de favoriser une industrie agricole durable sur le plan environnemental, sensible aux impacts du changement climatique et contribuant à la réduction des émissions de gaz à effet de serre.

L'éventail des rendements des cultures dans un champ est facilement visible à l'œil nu, mais la variabilité observée ne peut être quantifiée sans un système de contrôle des rendements monté sur un arrangeur et combine de grain.

Les données sur le rendement des cultures ont été fournies par onze producteurs pour neuf types de cultures sur quatre campagnes agricoles et environ 14 000 acres. Les données sur le rendement des fourrages et du maïs ensilage ont été recueillies auprès de sept exploitations qui ont fait appel aux services personnalisés de Greenleaf Harvesting. Les données restantes ont été fournies par les moissonneuses-batteuses et les contrôleurs de rendement des pommes de terre des producteurs. Toutes les données de rendement ont été exportées du JD Operations Center et traitées à l'aide du logiciel AgLeader SMS, puis interpolées dans des schémas en 2D.

Le potentiel d'amélioration des rendements sur le terrain varie selon les types de cultures. Cependant, sur l'ensemble de la surface cultivée d'environ 14 000 acres, le potentiel moyen d'amélioration du rendement sur le terrain pour toutes les espèces cultivées était d'environ 70 %. Environ 30 % de la surface cultivée a été considérée comme ayant un potentiel limité d'amélioration du rendement au cours des quatre années.

On a estimé que 47 % de la superficie totale des champs sur trois ans avaient un potentiel d'amélioration de l'efficacité des engrais si le pH était porté à 6,0.

Dans l'ensemble, les valeurs de corrélation pour chaque espèce cultivée avec les caractéristiques du sol étaient faibles (moins de 0,4), qu'elles soient positives ou négatives, ce qui indique qu'aucune caractéristique du sol n'a eu d'effet significatif sur le rendement des cultures.

Pour les années à venir, il conviendrait de collecter des informations sur les rendements des champs concernés et de les intégrer aux cartes d'application de chaux et d'engrais afin d'étudier l'ampleur de l'amélioration et le potentiel de durabilité à long terme et d'atténuation du changement climatique.

Conclusion

Il existe d'importantes possibilités d'amélioration du rendement dans un champ pour toutes les cultures signalées. La qualité des données de rendement enregistrées dépend fortement de la capacité de l'opérateur à gérer les réglages de la largeur de l'andain et l'étalonnage du moniteur de rendement et des capteurs associés.

La méthode SoilOptix® de quantification de l'état du sol offre une meilleure résolution des propriétés du sol que la méthode traditionnelle d'échantillonnage par quadrillage à l'hectare. SoilOptix® fournit également une caractérisation supplémentaire du type de sol, qui est un élément important de l'évaluation de la santé du sol. Grâce à la recherche, les données de SoilOptix® peuvent être mises en corrélation avec d'autres critères de santé des sols, tels que le carbone. Cela pourrait constituer un outil précieux pour les projets à venir de la Solution agriculture-climat au Nouveau-Brunswick.

L'échantillonnage géoréférencé ou en grille jouera un rôle important en tant que fondement de tout nouvel ensemble de données recueillies pour les membres. Les coordonnateurs de l'AASCNB 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 façon cohérente.

Les agriculteurs et les prestataires de services du secteur doivent mieux comprendre les méthodes d'analyse et d'interpolation utilisées pour créer les différentes cartes d'état et d'application présentées. Ce point est particulièrement important lorsqu'il s'agit de comparer la corrélation entre les résultats de l'échantillonnage géoréférencé et le rendement des cultures.

Ce projet a généré une grande quantité de données qui n'ont été que partiellement analysées. Une analyse plus poussée par des agronomes et des spécialistes des SIG permettra d'identifier les facteurs susceptibles d'améliorer la rentabilité, la compétitivité et la durabilité de la production végétale au Nouveau-Brunswick.

Project title and project number: NB Crop Production Optimization C1920-0035-Y4

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

Shaun Pelkey, Valley Farms-potato yield data

Ben Wohlgemouth, Greenleaf Harvesting, owner/operator **-** forage yield data

Summary.

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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 combine or harvester mounted yield monitor.

The objectives for the project activity are:

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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).
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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 was provided by eleven producers for nine crop types over four crop years and approximately 14,000 acres. Forage and corn silage yield data was collected from seven farms using custom services by Greenleaf Harvesting. The remaining data was provided by producer's grain combine and potato yield monitors. All yield 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. However, over the total crop area of approximately 14,000 acres the average in-field yield improvement potential for all crop species was approximately 70%. Approximately 30% of the field area was considered to have a limited potential for yield improvement across the four years.

Forty-seven per cent of the total field area over three years was estimated to have a potential fertilizer efficiency improvement if the pH was increased to 6.0.

Overall, the correlation values for each crop species with soil characteristics were low (less than 0.4) either positive or negative indicating that no single soil attribute had a significant effect on crop yield.

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.

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 Canadian Agricultural Partnership 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 and environmental sustainability. Evolving techniques associated with precision farming enable tailoring traditional production recommendations and cropping methods within the field to optimize yield, with minimal negative environmental impact.

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 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.

Material and Methods:

Crop yield data was provided by eleven producers for nine crop types over four crop years amounting to approximately 14,000 acres. Forage and corn silage yield data was collected from seven farms using custom services provided by Greenleaf Harvesting. The remaining data was provided by producer's grain combine and potato yield monitors. All yield data was exported from the JD Operations Center and processed using AgLeader SMS software. and interpolated in 2D layouts.

McCain Fertilizer provided geo-referenced fertility data using SoilOptix for approximately 1,400 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.

The magnitude of crop yield improvement potential was calculated by dividing the yield range reported for each crop into six ranges. The potential for in field yield improvement was estimated from the difference between the four lowest ranges and the second highest yield range for the corresponding area of the range divided by the total field area. Forage yield reported is from a single cut either a first or second cut.

The potential fertilizer efficiency improvement was calculated by dividing the pH range reported for each field into six ranges [<4.5,4.5-5.0,5.0-5.5,5.5-6.0,6.0-6.5,>6.5]. The potential for in field fertilizer efficiency improvement was calculated from Pub534-84 Atlantic Soils Need Lime as modified by Perennia December 2021 to a maximum of pH 6.0.

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 map-based products were delivered to participating cooperators annually.

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 opportunity to scan the blueberry area in NB and other areas beyond the local health zone was lost.

Consistent field identification by the farm owners, machine operators and custom service providers was an issue across all years for efficient GIS data processing.

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

Soil textural classification using the USDA triangle in SMS from the SoilOptix® data collected and a correlation analysis of yield to soil parameters were prepared and presented in interim reports as presented in Appendix Illustrations 3 and 4.

Cooperators provided access to yield data for nine crop types. Summary tables were prepared for all cooperators for each crop for 2019, 2020,2021 and 2022. These tables with the 2D yield maps were 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 Appendix Tables 1-9, attached.

Across all years within field potential forage yield improvement was estimated to average 1.1 ton per acre.

Across all years within field potential corn silage yield improvement was estimated to average 3.0 ton per acre.

Across all years within field potential wheat yield improvement was estimated to average 27.3 bushels per acre.

Across all years within field potential oat yield improvement was estimated to average 12.6 bushels per acre.

Across all years within field potential barley yield improvement was estimated to average 9.1 bushels per acre.

Across all years within field potential soybean yield improvement was estimated to average 20.4 bushels per acre.

Across all years within field potential grain corn yield improvement was estimated to average 26.0 bushels per acre.

Across all years within field potential potato yield improvement was estimated to average 78.1 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.

The potential area for in-field yield improvement varied between the crop species as summarized in Table 1, below. The overall area, with yield potential improvement corresponded with the weather variability observed for each of the growing seasons.

TABLE 1: % of Field Area with Yield Improvement Potential All Years 2019,2020,2021,2022									POTENTIAL IMPROVEMEN	
CROP	Total Area		Range 1	Range 2	Range 3	Range 4	Range 5	Range 6		Yield Units
Grain Corn	3,051		18	16	15	24	22	6	**26.0**	bu/ac
Oat	1,747		12	17	12	12	18	30	**12.6**	bu/ac
Soybean	1,693		5	19	31	23	13	9	**20.4**	bu/ac
Corn Silage	825		9	12	30	39	8	2	**3.0**	DM Ton/ac
Forage	1,228		19	23	21	15	10	12	**1.1**	DM Ton/ac
Wheat	1,726		28	26	27	15	3	2	**27.3**	bu/ac
Barley	1,142		19	12	15	17	17	20	**9.1**	bu/ac
Annual Forage	76		2	7	15	18	19	39	**0.4**	DM Ton/ac
CobMeal	17		20	17	16	16	16	15	**1.0**	DM Ton/ac
Potato	2,630		17	10	19	21	16	17	**78.1**	cwt/ac
All Crops:	**14,135**	**Average=**	**15**	**16**	**20**	**20**	**14**	**15**		
		Total Area with Improvement Potential =				**71%**				
			Area with Limited Improvement Potential=					**29%**		
*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.										

A large difference for in field potential potato yield improvement between locations in New Brunswick in 2022 was reported, below.

Potato In-field Potential Yield Improvement for Monitored Field Area									
			Average % of Field Area						Cwt
Field	Area	< 150	150-200	200-250	250-300	300-350	>350	POTENTIAL IMPROVEMENT*	per Ac.
Carleton	**1057**	**15.7**	**8.9**	**12.5**	**20.5**	**22.6**	**19.8**	**Overall Field Area Average(cwt/ac):**	**63.5**
Madawaska	**829**	**0.9**	**1.3**	**2.4**	**5.1**	**9.7**	**80.6**	**Overall Field Area Average(cwt/ac):**	**8.4**

Table 2 (below) illustrates the three-year average overall potential fertilizer efficiency improvement. Forty-seven per cent of the total field area has a potential fertilizer efficiency improvement if the pH was increased to 6.0.

Table 2: Potential Fertilizer Efficiency Improvement by Field Area														
									POTENTIAL OVERALL IMPROVEMENT*					
		% of Field Area x pH Range							Field Area (ac.) x % Improvement					Total Area
Year		<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	**Avg.=**	0	0	7	15	54	16		0	9	29	158	43	213
					% of Total Area				0	4	14	74	20	
2021	**Avg.=**	0.5	3.9	26.9	27	33	9		10	67	60	65	11	212.3
					% of Total Area				5	32	28	30	5	
2022	**Avg.=**	0.0	0.2	18.3	51.9	25.0	4.6		0.4	54.0	219.3	163.9	33.8	471.3
					% of Total Area				0	11	47	35	7	
3 Year	**Avg.=**	**0.2**	**1.4**	**17.5**	**31.1**	**37.1**	**9.9**		**3.3**	**43.4**	**102.7**	**128.9**	**29.2**	**896.8**
					% of Total Area				**2**	**16**	**29**	**46**	**11**	

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

Table 3, below, illustrates the average variable rate lime application required to raise the soil pH to 6.3in the fall of 2019 and 2020 and the fall of 2022 after two and three annual crops were harvested.

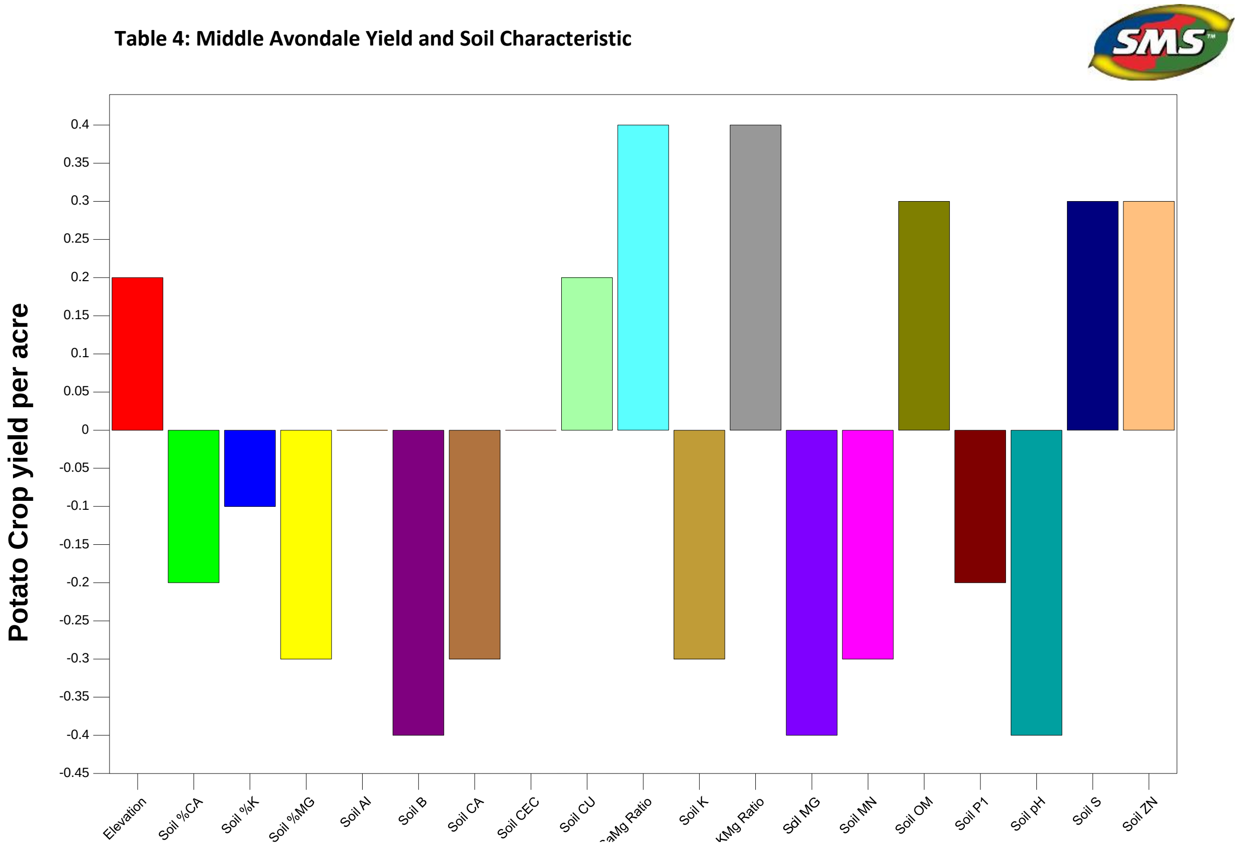
Table 3: Average Lime Application Rate (lb/Ac) to pH 6.3 *							
Field #	Area (ac.)	Year	pH	Average Rate lb/ac	Year	pH	Average Rate lb/ac
1	63.4	2020		3,196	2022		607
2	84.5	2020	5.8	2,714	2022	6.5	149
3	52.0	2019	5.6	4,671	2022	6.3	990
4	52.5	2019	5.4	5,387	2022	6.2	1,461
5	38.3	2020		1,690	2022		2,498

* McCain Fertilizer SoilOptix

Soil texture classifications from the SoilOptix® data were calculated using the SMS software for each field as presented in Appendix Illustration 3.

A geospatial correlation of yield to soil attributes reported by SoilOptix® were calculated using the SMS software for each crop kind as illustrated in Table 4 (below), and Appendix Tables 11 and 12 and Appendix Illustration 4. Overall, the correlation values for each crop species with soil characteristics were low (less than 0.4) either positive or negative indicating that no single soil attribute had a significant effect on crop yield. Soil attributes showed a higher correlation to each other as expected.

Table 4: Middle Avondale Yield and Soil Characteristic



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 managed swath width settings and calibration of the yield monitor and related sensors.

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.

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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 crop yield.

This project activity 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.

Required next steps.

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 enhanced 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 will be essential to support best management practices to reduce greenhouse gas emissions.

Communication:

The information generated by this project will be available in the final report and will be presented at various provincial and local meetings as requested.

Appendix Tables 1-9: C1920-0035-Y4 NB Crop Production Optimization Final Report

Table 1: Forage Potential Yield Improvement for Monitored Field Area

			Average Area x Yield Range (Dry Tons)						Average % of Field Area x Yield Range (Dry Tons)						POTENTIAL IMPROVEMENT* (DM 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	550	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	6.9	6.5	6.2	5.8	5.4	4.3	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
2022	Total	270	12.2	8.2	5.4	4.0	2.3	4.4	16.5	20.1	17.9	17.5	10.4	17.7	1.1
Summary		**1228**	8.8	8.6	7.2	4.9	3.0	3.5	19.1	23.3	20.8	15.4	9.6	11.8	**1.1**

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

			Average Area x Yield Range (Dry Tons)						Average % of Field Area x Yield Range (Dry Tons)						POTENTIAL IMPROVEMENT* (DM 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
2022	Total	169	2.5	4.5	6.5	4.7	1.7	1.2	11.5	21.8	34.3	20.1	6.4	5.8	3.8
Summary		**825**	2.0	3.2	11.8	21.0	4.4	0.5	9.0	11.7	30.3	39.4	8.1	1.6	**3.0**

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	<40	40-55	55-70	70-85	85-100	>100	
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
2022	Total	871	3.2	12.0	23.5	8.3	2.0	2.3	7.7	25.6	40.2	17.0	4.4	5.1	30.0
Summary		**1726**	11.1	12.2	16.5	7.2	1.0	0.7	27.7	26.3	27.1	14.5	2.8	1.5	**27.3**

Table 4: Oat 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.)	<95	95-105	105-115	115-125	125-135	>135	<95	95-105	105-115	115-125	125-135	>135	
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
2022			<105	105-135	135-145	145-155	155-165	>165	<105	105-135	135-145	145-155	155-165	>165	
2022	Total	1051	3.1	4.5	2.7	3.1	3.3	12.6	12.0	14.6	9.4	10.7	11.7	41.7	14.8
Summary		**1747**	6.4	9.2	7.1	7.0	11.0	15.6	11.5	16.7	11.8	12.2	18.3	29.5	**12.6**

Table 5: Barley 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.)	<60	60-65	65-70	70-75	75-80	>80	<60	60-65	65-70	70-75	75-80	>80	
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
2022	Total:	457	1.3	2.8	5.7	9.9	12.1	9.8	3.4	8.8	17.4	24.3	28.1	18.0	9.7
Summary		1142	17.6	9.4	10.6	11.5	11.8	15.7	19.3	12.1	15.1	16.5	16.9	20.2	9.1

Table 6: Soybean 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.)	<20	20-30	30-40	40-50	50-60	>60	< 20	20-30	30-40	40-50	50-60	>60	
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
2022	Total	456	0.8	2.3	5.8	10.5	10.3	8.3	3.3	9.1	18.9	26.9	22.6	19.2	10.3
Summary		1693	2.1	10.2	14.2	10.1	6.8	4.7	5.2	18.9	31.3	22.5	13.0	9.1	20.4

Table 7: Grain Corn 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.)	<80	80-100	100-120	120-140	140-160	>160	<80	80-100	100-120	120-140	140-160	>160	
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
2022	Total	855	5.8	5.5	18.4	32.7	17.9	5.4	8.1	5.7	14.1	32.8	30.4	8.8	20.9
Summary		3051	10.4	8.7	11.5	19.4	13.2	4.5	17.5	15.5	15.0	23.6	22.0	6.4	26.0

Table 8: 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
2022	Total	1886	5.5	3.6	5.3	8.7	10.5	27.2	12.8	7.4	10.5	17.6	20.1	31.6	52.9
Summary		2630	6.1	4.1	7.5	8.3	7.1	11.7	17.0	10.4	18.9	21.2	15.8	16.6	78.1

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.

Appendix Table 10: Potential Fertilizer Efficiency Improvement by Field Area

																	POTENTIAL OVERALL IMPROVEMENT*					
		Total Area	pH Range x Field Area (ac.)							% of Field Area x pH Range							Field Area (ac.) x % Improvement					Total Area
Year	Field		<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	1	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
	2	77.6				14.4	51.2	12		0.0	0.0	0.0	18.6	66.0	15.5		0.0	0	14.4	51.2	12	77.6
	3	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
	4	52.4					35.8	16.6		0.0	0.0	0.0	0.0	68.3	31.7		0.0	0	0	35.8	17	52.4
	5	85.13			0.4	54.3	25.8	4.7		0.0	0.0	0.4	63.7	30.4	5.5		0.0	0.38	54.3	25.8	4.7	85.1
2020	**Total**	**213.1**						**Avg.=**		0	0	7	15	54	16		0	9	29	158	43	213
													% of Total Area				0	4	14	74	20	

2021	1	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	5.99	21.2	0.5	33.7
	2	12.0				0.17	6.15	5.66	0.0	0.0	0.0	1.4	51.3	47.2		0.0	0	0.17	6.15	5.7	12.0
	3	39.7				18.17	19.44	2.07	0.0	0.0	0.0	45.8	49.0	5.2		0.0	0	18.2	19.4	2.1	39.7
	4	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	6.14	1.24	0	45.2
	5	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
	6	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	12.3	0.05	0	23.6
	7	26.4				6.91	16.49	2.98	0.0	0.0	0.0	26.2	62.5	11.3		0.0	0	6.91	16.5	3	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	212
												% of Total Area				5	32	28	30	5	
2022	1	85.1	0	0			63.9	21.2	0.0	0.0	0.0	0.0	75.1	24.9		0.0	0	0	63.9	21	85.1
	2	40.3	0	0		39	1.3		0.0	0.0	0.0	96.8	3.2	0.0		0.0	0	39	1.3	0	40.3
	3	81.4	0	0			69.4	12	0.0	0.0	0.0	0.0	85.3	14.7		0.0	0	0	69.4	12	81.4
	4	81.0	0	0	0.09	80.9			0.0	0.0	0.1	99.9	0.0	0.0		0.0	0.09	80.9	0	0	81.0
	5	40.3	0	0	0.37	25.3	14	0.6	0.0	0.0	0.9	62.8	34.8	1.5		0.0	0.37	25.3	14	0.6	40.3
	6	70.9	0	0	21.22	36.3	13.4	0.02	0.0	0.0	29.9	51.2	18.9	0.0		0.0	21.2	36.3	13.4	0	70.9
	7	24.3	0	0	13.4	10.88			0.0	0.0	55.2	44.8	0.0	0.0		0.0	13.4	10.9	0	0	24.3
	8	25.2	0	0	9.4	14.6	1.2		0.0	0.0	37.3	57.9	4.8	0.0		0.0	9.4	14.6	1.2	0	25.2
	9	22.9	0	0.4	9.5	12.3	0.66		0.0	1.7	41.6	53.8	2.9	0.0		0.4	9.5	12.3	0.66	0	22.9
2022		**471.3**						**Avg.=**	0.0	0.2	18.3	51.9	25.0	4.6		0.4	54.0	219.3	163.9	33.8	471.3
												% of Total Area				0	11	47	35	7	

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

Appendix Table 11: Correlation of Wheat Yield and Soil Characteristics (2019)

WHEAT-2019 ATTRIBUTE	Yield (Dry)	Elevation	HZ1 - Soil % Clay	HZ1 - Soil % Loam	HZ1 - Soil % Sand	HZ1 - Soil % Silt	Plant Avail Water	Soil %CA	Soil %K	Soil %MG	Soil Al	Soil B	Soil BpH	Soil CA	Soil CEC	Soil CU	Soil CaMg	Soil K	Soil KMg	Soil Leakability	Soil MG	Soil OM	Soil P1	Soil ZN	Soil pH
Yield (Dry)	1	-0.1	0.3	0.1	-0.1	-0.3	-0.1	0.1	-0.1	-0.3	-0.3	0.1	0	0.2	0.3	0.2	0.2	0.1	0.2	0.3	-0.1	-0.3	0	0.4	0.3
Elevation	-0.1	1	-0.4	0.1	-0.1	0.5	0.1	0	-0.2	0.4	0.4	-0.4	0	0.1	0.1	-0.2	-0.1	-0.1	-0.4	-0.5	0.5	0.1	0.4	-0.2	-0.3
HZ1 - Soil % Clay	0.3	-0.4	1	0.5	-0.5	-0.6	0.1	0.5	-0.1	-0.6	-1	0.7	0	0.6	0.4	0.1	0.7	0.3	0.5	1	-0.4	-0.9	-0.4	0.7	0.9
HZ1 - Soil % Loam	0.1	0.1	0.5	1	-1	0.4	0.9	0.6	-0.2	0.3	-0.5	0.4	0	0.4	-0.1	-0.7	0.2	-0.3	-0.4	0.4	0.3	-0.5	-0.3	0.2	0.5
HZ1 - Soil % Sand	-0.1	-0.1	-0.5	-1	1	-0.4	-0.9	-0.6	0.2	-0.3	0.5	-0.4	0	-0.4	0.1	0.7	-0.2	0.3	0.4	-0.4	-0.3	0.5	0.3	-0.2	-0.5
HZ1 - Soil % Silt	-0.3	0.5	-0.6	0.4	-0.4	1	0.7	0	-0.1	0.9	0.6	-0.4	0	-0.3	-0.6	-0.7	-0.5	-0.6	-0.9	-0.7	0.7	0.5	0.2	-0.6	-0.6
Plant Avail Water	-0.1	0.1	0.1	0.9	-0.9	0.7	1	0.4	-0.2	0.6	-0.1	0.2	0	0.2	-0.4	-0.8	-0.1	-0.5	-0.7	0.1	0.5	-0.1	-0.3	-0.1	0.1
Soil %CA	0.1	0	0.5	0.6	-0.6	0	0.4	1	-0.4	-0.1	-0.5	0.4	0	0.9	0.2	-0.4	0.8	-0.1	-0.1	0.5	0	-0.5	-0.4	0.3	0.7
Soil %K	-0.1	-0.2	-0.1	-0.2	0.2	-0.1	-0.2	-0.4	1	0	0.1	0	0	-0.4	-0.2	0.3	-0.3	0.5	0.4	0	-0.2	0.1	0	0.1	-0.2
Soil %MG	-0.3	0.4	-0.6	0.3	-0.3	0.9	0.6	-0.1	0	1	0.6	-0.5	0	-0.4	-0.6	-0.6	-0.7	-0.5	-0.9	-0.6	0.8	0.5	0.3	-0.5	-0.6
Soil Al	-0.3	0.4	-1	-0.5	0.5	0.6	-0.1	-0.5	0.1	0.6	1	-0.7	0	-0.6	-0.4	-0.1	-0.7	-0.3	-0.5	-1	0.4	0.9	0.4	-0.7	-0.9
Soil B	0.1	-0.4	0.7	0.4	-0.4	-0.4	0.2	0.4	0	-0.5	-0.7	1	0	0.2	-0.1	-0.3	0.6	-0.1	0.4	0.7	-0.7	-0.6	-0.8	0.1	0.7
Soil BpH	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Soil CA	0.2	0.1	0.6	0.4	-0.4	-0.3	0.2	0.9	-0.4	-0.4	-0.6	0.2	0	1	0.7	0	0.9	0.2	0.1	0.5	0	-0.6	-0.1	0.5	0.8
Soil CEC	0.3	0.1	0.4	-0.1	0.1	-0.6	-0.4	0.2	-0.2	-0.6	-0.4	-0.1	0	0.7	1	0.6	0.6	0.7	0.4	0.4	0	-0.4	0.3	0.7	0.5
Soil CU	0.2	-0.2	0.1	-0.7	0.7	-0.7	-0.8	-0.4	0.3	-0.6	-0.1	-0.3	0	0	0.6	1	0.1	0.8	0.6	0.1	-0.2	-0.1	0.5	0.6	0
Soil CaMg	0.2	-0.1	0.7	0.2	-0.2	-0.5	-0.1	0.8	-0.3	-0.7	-0.7	0.6	0	0.9	0.6	0.1	1	0.2	0.5	0.6	-0.5	-0.7	-0.4	0.4	0.8
Soil K	0.1	-0.1	0.3	-0.3	0.3	-0.6	-0.5	-0.1	0.5	-0.5	-0.3	-0.1	0	0.2	0.7	0.8	0.2	1	0.7	0.3	-0.1	-0.3	0.2	0.7	0.2
Soil KMg	0.2	-0.4	0.5	-0.4	0.4	-0.9	-0.7	-0.1	0.4	-0.9	-0.5	0.4	0	0.1	0.4	0.6	0.5	0.7	1	0.5	-0.8	-0.4	-0.2	0.4	0.4
Soil Leakability	0.3	-0.5	1	0.4	-0.4	-0.7	0.1	0.5	0	-0.6	-1	0.7	0	0.5	0.4	0.1	0.6	0.3	0.5	1	-0.5	-0.8	-0.5	0.7	0.9
Soil MG	-0.1	0.5	-0.4	0.3	-0.3	0.7	0.5	0	-0.2	0.8	0.4	-0.7	0	0	0	-0.2	-0.5	-0.1	-0.8	-0.5	1	0.3	0.5	0	-0.4
Soil OM	-0.3	0.1	-0.9	-0.5	0.5	0.5	-0.1	-0.5	0.1	0.5	0.9	-0.6	0	-0.6	-0.4	-0.1	-0.7	-0.3	-0.4	-0.8	0.3	1	0.2	-0.7	-0.8
Soil P1	0	0.4	-0.4	-0.3	0.3	0.2	-0.3	-0.4	0	0.3	0.4	-0.8	0	-0.1	0.3	0.5	-0.4	0.2	-0.2	-0.5	0.5	0.2	1	0.2	-0.6
Soil ZN	0.4	-0.2	0.7	0.2	-0.2	-0.6	-0.1	0.3	0.1	-0.5	-0.7	0.1	0	0.5	0.7	0.6	0.4	0.7	0.4	0.7	0	-0.7	0.2	1	0.5
Soil pH	0.3	-0.3	0.9	0.5	-0.5	-0.6	0.1	0.7	-0.2	-0.6	-0.9	0.7	0	0.8	0.5	0	0.8	0.2	0.4	0.9	-0.4	-0.8	-0.6	0.5	1

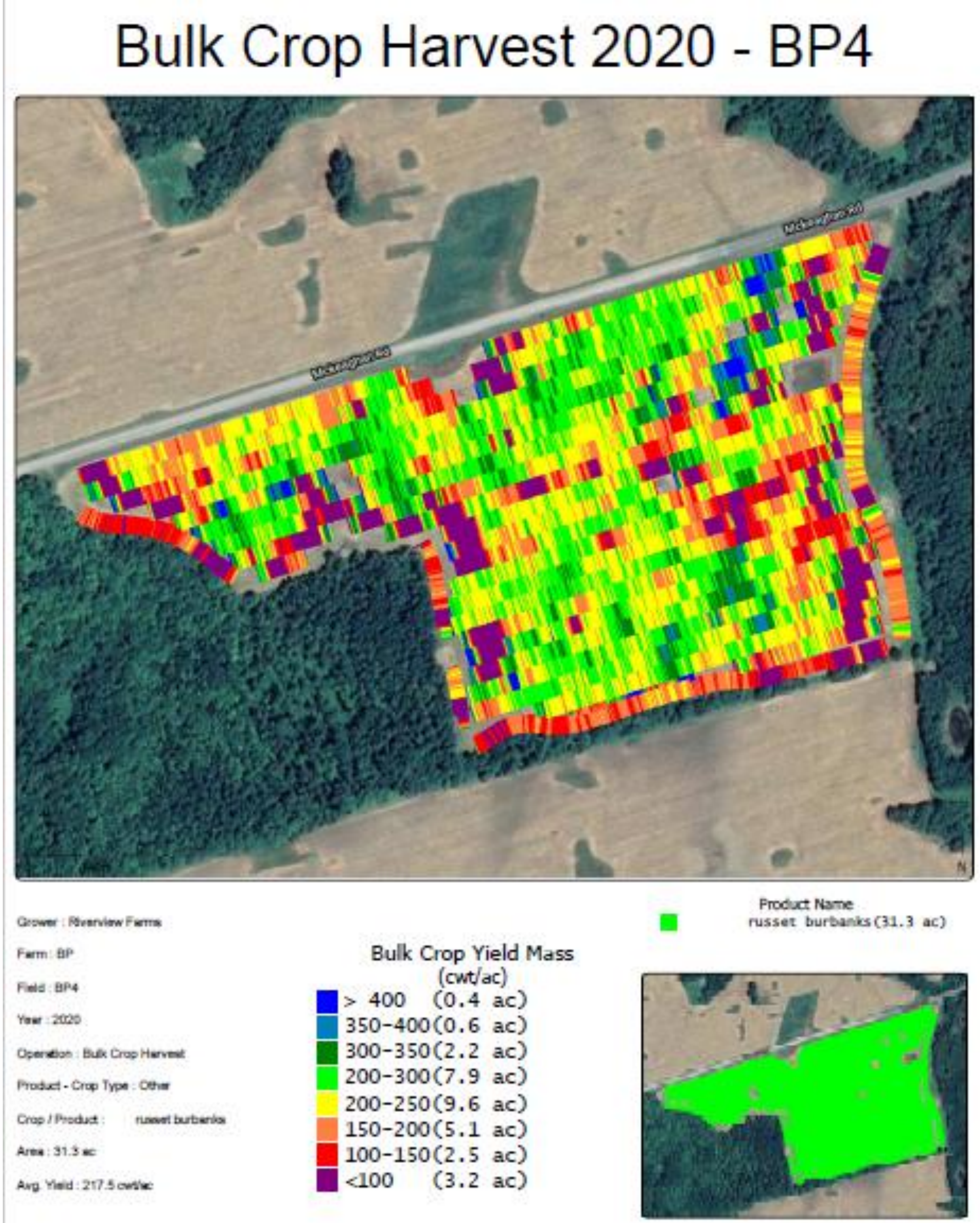
How to Interrupt the Correlation Chart

As pH increases yield increases 30% of the time
As OM increases yield decreases 30% of the time
As Mg increases yield decreases 10% of the time
As Ca increases yield increases 20% of the time
As K increases yield increases 10% of the time
As Elevation increases yield decreases 10% of the time
As Elevation increases B decreases 40% of the time
As % Clay increases yield increases 30% of the time
As CEC increases yield increases 30% of the time

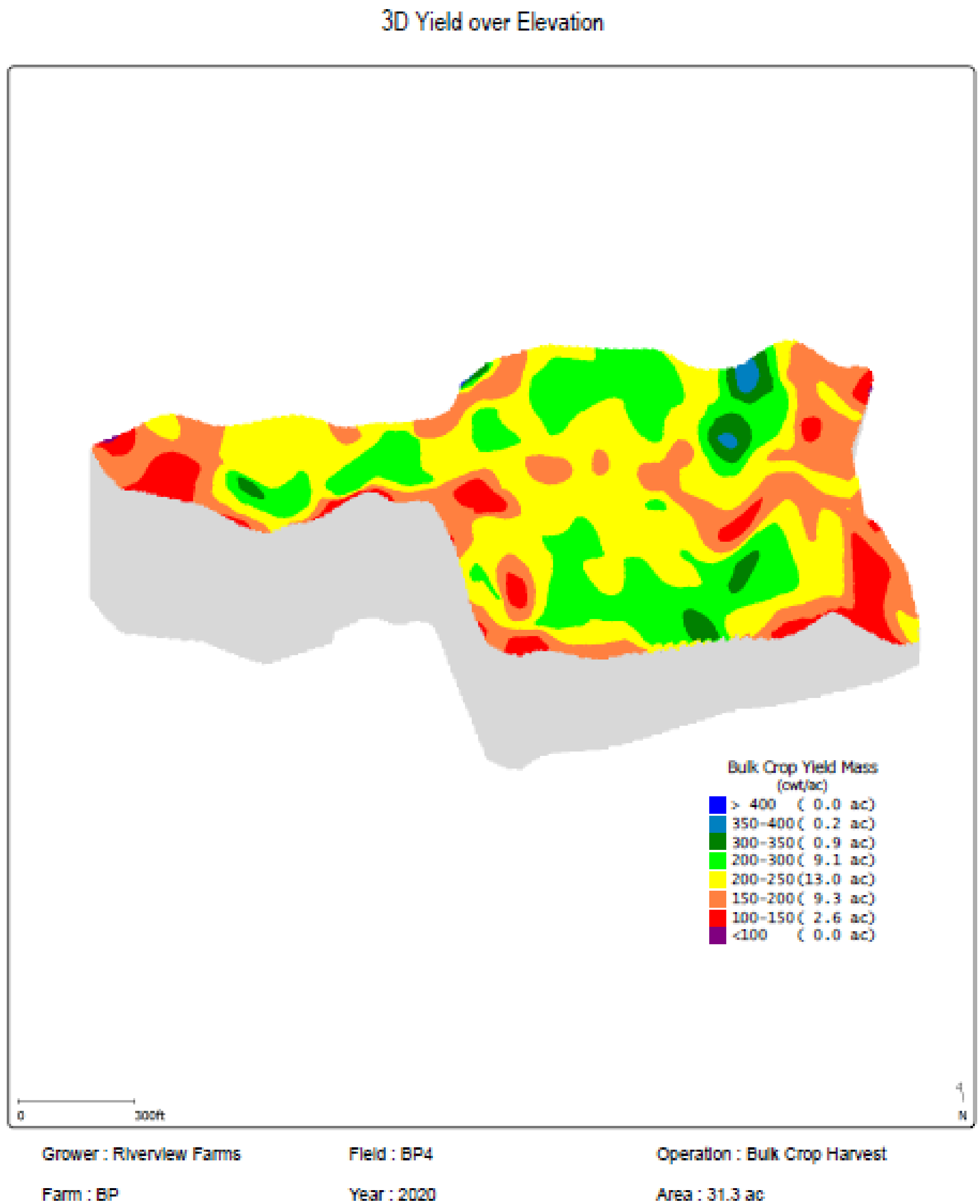
Appendix Table 12: Correlation of Potato Yield and Soil Characteristics (2022)

Middle Avondale	Bulk crop yield per acre	Elevation	Soil %CA	Soil %K	Soil %MG	Soil Al	Soil B	Soil CA	Soil CEC	Soil CU	Soil CaMg Ratio	Soil K	Soil KMg Ratio	Soil MG	Soil MN	Soil OM	Soil P1	Soil pH	Soil S	Soil ZN
Bulk crop yield per acre	1	0.2	-0.2	-0.1	-0.3	0	-0.4	-0.3	0	0.2	0.4	-0.3	0.4	-0.4	-0.3	0.3	-0.2	-0.4	0.3	0.3
Elevation	0.2	1	0.5	0.5	0.4	-0.1	0.2	0.2	-0.4	-0.1	-0.2	0.3	-0.1	0.2	0.3	-0.1	-0.7	0.1	-0.3	-0.1
Soil %CA	-0.2	0.5	1	1	0.9	-0.6	0.4	0.3	-0.9	-0.6	-0.5	0.7	-0.1	0.4	0.7	-0.3	-0.5	0.3	-0.7	-0.3
Soil %K	-0.1	0.5	1	1	0.9	-0.7	0.4	0.2	-0.9	-0.7	-0.5	0.8	-0.1	0.4	0.8	-0.4	-0.5	0.3	-0.8	-0.4
Soil %MG	-0.3	0.4	0.9	0.9	1	-0.4	0.8	0.6	-0.6	-0.7	-0.8	0.9	-0.5	0.8	0.9	-0.7	-0.2	0.6	-0.9	-0.7
Soil Al	0	-0.1	-0.6	-0.7	-0.4	1	0.1	0.4	0.8	0.8	0.1	-0.4	-0.4	0.1	-0.4	0.2	0.6	0.3	0.4	0.2
Soil B	-0.4	0.2	0.4	0.4	0.8	0.1	1	0.9	0	-0.4	-1	0.8	-0.9	1	0.8	-0.8	0.3	0.9	-0.8	-0.8
Soil CA	-0.3	0.2	0.3	0.2	0.6	0.4	0.9	1	0.2	0	-0.7	0.7	-0.8	0.9	0.7	-0.4	0.4	1	-0.7	-0.4
Soil CEC	0	-0.4	-0.9	-0.9	-0.6	0.8	0	0.2	1	0.6	0.2	-0.5	-0.2	0	-0.5	0.1	0.6	0.1	0.5	0.1
Soil CU	0.2	-0.1	-0.6	-0.7	-0.7	0.8	-0.4	0	0.6	1	0.6	-0.6	0.2	-0.4	-0.6	0.7	0.3	-0.1	0.6	0.7
Soil CaMg Ratio	0.4	-0.2	-0.5	-0.5	-0.8	0.1	-1	-0.7	0.2	0.6	1	-0.8	0.9	-1	-0.8	0.9	-0.2	-0.8	0.8	0.9
Soil K	-0.3	0.3	0.7	0.8	0.9	-0.4	0.8	0.7	-0.5	-0.6	-0.8	1	-0.5	0.8	1	-0.6	-0.1	0.7	-1	-0.6
Soil KMg Ratio	0.4	-0.1	-0.1	-0.1	-0.5	-0.4	-0.9	-0.8	-0.2	0.2	0.9	-0.5	1	-0.9	-0.5	0.7	-0.5	-0.8	0.5	0.7
Soil MG	-0.4	0.2	0.4	0.4	0.8	0.1	1	0.9	0	-0.4	-1	0.8	-0.9	1	0.8	-0.8	0.3	0.9	-0.8	-0.8
Soil MN	-0.3	0.3	0.7	0.8	0.9	-0.4	0.8	0.7	-0.5	-0.6	-0.8	1	-0.5	0.8	1	-0.6	-0.1	0.7	-1	-0.6
Soil OM	0.3	-0.1	-0.3	-0.4	-0.7	0.2	-0.8	-0.4	0.1	0.7	0.9	-0.6	0.7	-0.8	-0.6	1	-0.2	-0.5	0.6	1
Soil P1	-0.2	-0.7	-0.5	-0.5	-0.2	0.6	0.3	0.4	0.6	0.3	-0.2	-0.1	-0.5	0.3	-0.1	-0.2	1	0.5	0.1	-0.2
Soil pH	-0.4	0.1	0.3	0.3	0.6	0.3	0.9	1	0.1	-0.1	-0.8	0.7	-0.8	0.9	0.7	-0.5	0.5	1	-0.7	-0.5
Soil S	0.3	-0.3	-0.7	-0.8	-0.9	0.4	-0.8	-0.7	0.5	0.6	0.8	-1	0.5	-0.8	-1	0.6	0.1	-0.7	1	0.6
Soil ZN	0.3	-0.1	-0.3	-0.4	-0.7	0.2	-0.8	-0.4	0.1	0.7	0.9	-0.6	0.7	-0.8	-0.6	1	-0.2	-0.5	0.6	1

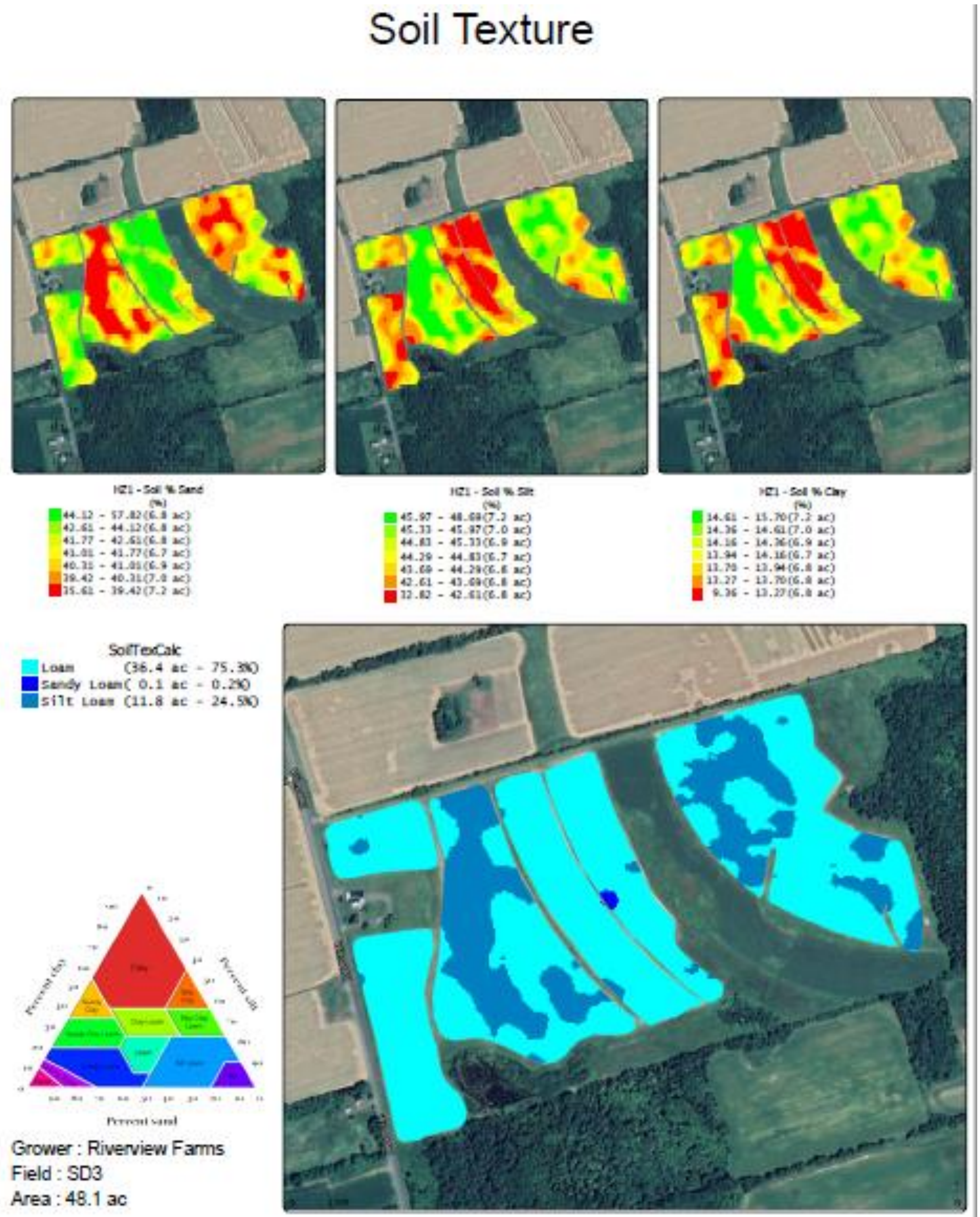
Appendix Illustration 1: 2D Potato Yield



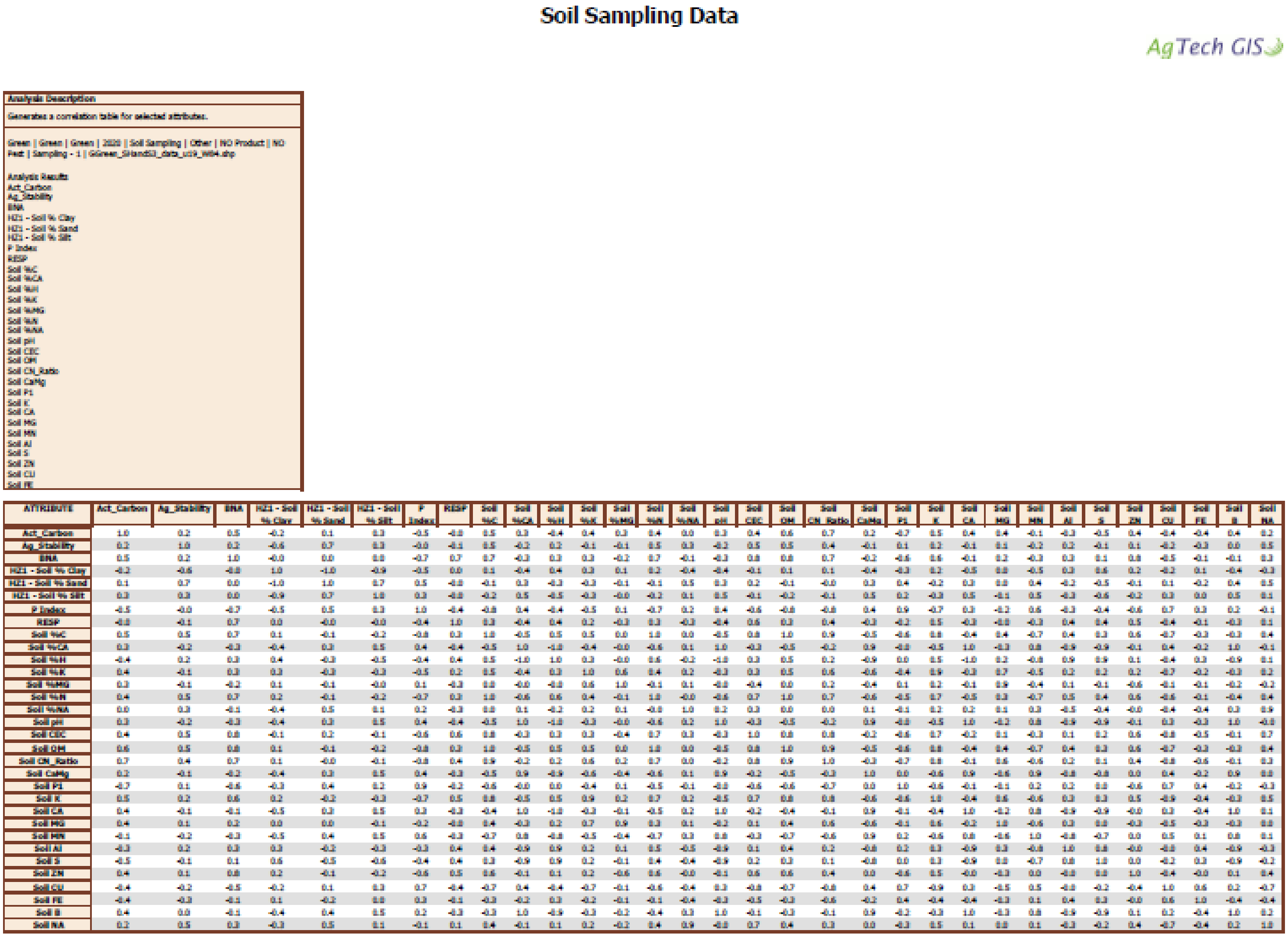
Appendix Illustration 2: 3D Potato Yield



Appendix Illustration 3: SoilOptix® Soil Texture Classification from SMS



Appendix Illustration 4 : SMS Correlation Analysis



ATTRIBUTE	Act_Carbo	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