

A Review of the Potential for an Ontario Soil Database

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Introduction

Late 2020, Fertilizer Canada was given the opportunity to serve as a lead partner on the Ontario Soil Data project with the original intention of the project being to collect soil data on an agreed spatial scale of sub-units within the province of Ontario. Previous projects completed by Fertilizer Canada's sister organization, The Fertilizer Institute (TFI) and Plant Nutrition Canada (PNC), reported soil test data at a state/provincial level through the successful [Soil Test Summary](#). This work offered a foundational platform of experience to build upon when developing a similar methodology for soil data collection in Ontario.

Due to unforeseen challenges with grower data privacy and data collection, Fertilizer Canada and OMAFRA agreed to adjust the project objectives with the aim of completing a summary report that would analyze the challenges and barriers encountered when attempting to collect sub-provincial soil data at this time. The following summary report is based upon past project experience and our specific discussion with provincial stakeholders to provide our best recommendation on how this type of project may be successfully implemented in the future. The key deliverable of this project is to outline the expressed concerns of Ontario stakeholders as it relates to the project in a way that will help better define the needs of the stakeholders involved.

Ontario agriculture has been a leader in implementing Best Management Practices (BMP's) to help improve soil health. Programs such as the 4R Nutrient Stewardship Certification Program, Lake Erie Agriculture Demonstrating Sustainability (LEADS), and other Soil Health Initiatives continue to be driven by Ontario farmers. One key concept is 'you cannot manage what you don't measure.' There is a need for measurement tools to show what is being implemented within these regions and showcase the positive impacts these BMPs have on soil health. The Ontario Soil Data project is an opportunity to start measuring and reporting on soil health across the province.

Fertilizer Canada believes it is critically important that the Ontario agricultural community work collaboratively on this project to ensure its success and benefit to all stakeholders involved. Knowledge of the distribution of soil fertility in Ontario is important to help inform the proper interpretation of nutrient budgets and balances for nutrients retained in soils, particularly phosphorus and potassium. Other aspects of soil fertility, including soil pH and soil organic matter levels, also contribute to the productivity and health of soils. We have worked with Plant Nutrition Canada to help develop some examples below of similar projects to help guide this project's development.

Brief Summary of Project Activity

1. Representatives from Fertilizer Canada and Plant Nutrition Canada met with selected representatives of soil test laboratories. It was noted that while most soil test laboratories did not see any conflict with sharing data on the basis of the province or state of origin of the sample, providing the county or tertiary watershed of the sample would require the cooperation and consent of agricultural service providers submitting samples. It was also noted that consent for such a project should be obtained from farm groups.
2. Several meetings were held with farm groups, presenting the project as one seeking data at the county and watershed spatial scale (tertiary watersheds were intended, but not explicitly defined). Farm group representatives raised concerns about this approach and noted that principles of informed consent implied that each farmer submitting soil samples would need to provide consent for the data to be used in this way.
3. Unfortunately, the rigor of informed consent requirements was such that it would have very likely resulted in the project becoming infeasible to implement (time requirement to contact thousands of farmers) and biased results (farmers with soils that were further from optimal levels of various soil fertility and soil health measures might be less likely to consent.)
4. There was also an expression from the farm groups that there would need to be a more informed approach which involved active participation of the funding organization (OMAFRA) to ensure that the intent of the project was proactively outlined to ensure greater transparency on the “why” for the project.
5. During the consultation with the farm groups, we had the opportunity to communicate/interview organizations that previously worked on similar soil data collection projects. These discussions helped shape our summary report and provided insight into what is currently being done as it relates to soil data collection in Ontario and how to best meet grower data protection needs.

Identified Barriers

Transparency on the purpose

Some of the difficulties encountered in this project arose from lack of clarity as to the end purpose and use of collected data. Although Fertilizer Canada made attempts to explain that the purpose of the project was to measure data to support voluntary industry-led programs, such as the 4R Nutrient Stewardship Certification program and the Lake Erie Demonstrating Sustainability (LEADS) program, some stakeholders questioned government's (OMAFRA) objectives for the project.

Under *PIPEDA Fair Information Principle 2- Identifying Purpose*¹ the need to identify and document the purpose for collecting data is highlighted. The purpose needs to be defined to the person whose data is accessed either prior to or during the period of access. If the intent changes to utilize the data for a different purpose, there is a need to return to individuals who provide the data and ask for their permission to update. For example, for this project Fertilizer Canada defines the purpose as "to develop a meaningful data set to showcase the impact of voluntary stewardship activities such as the Lake Erie Agriculture Demonstrating Sustainability and the 4R Nutrient Stewardship program" and if there is change from this purpose, the project would be unable to share the data until all the parties identified have given permission for their data to be utilized in this method. With the final project being funded and any final products owned by the province, it gives concern for groups on how Fertilizer Canada can define the purpose. In the future, if the province wants to collect and display this level of data there should be a clearly defined purpose from the government to ensure stakeholders are comfortable and supportive of the proposed project.

One final thing to note when defining the purpose, is the fair information principles. The white paper "Modernizing Privacy in Ontario"² notes the need for the following factors to be considered.

- 1. The volume, nature and sensitivity of the personal information, including whether the organization has taken steps to de-identify the personal information.*
- 2. Whether the collection, use or disclosure is necessary to achieve the legitimate needs of the organization.*
- 3. Whether there are less intrusive means of achieving those purposes at a comparable cost and with comparable benefits.*

¹ https://www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/the-personal-information-protection-and-electronic-documents-act-pipeda/p_principle/principles/p_purposes/

² <https://www.ontariocanada.com/registry/showAttachment.do?postingId=37468&attachmentId=49462>

- 4. Whether the individual's loss of privacy is proportionate to the benefits in light of any measures, technical or otherwise, implemented by the organization to mitigate the impacts of the loss of privacy on the individual.*

As we move through this Fertilizer Canada attempts to answer the above question for the currently defined purpose: "to develop a meaningful data set to showcase the impact of voluntary stewardship activities such as the Lake Erie Agriculture Demonstrating Sustainability and 4R Nutrient Stewardship program"- but notes that in any future iterations of this project it will be required for all parties to agree with the purpose prior to the start of such project.

Data Ownership

During stakeholder discussions, it was apparent that all data collected through any soil data project needs to be transparent to the owner of the data, which is defined as the grower who is paying to have the soil sampled and analyzed. Consent from farmers for the use of soil test data, or at least the participation of organizations representing farmers, was identified as a condition for data-sharing in early 2021 discussions with labs who analyze samples.

We note that laboratories differ in the disclosure of their policies on protection of the personal information submitted by their clients. In one example ([SGS](#)) personal data is defined as any information which relates to an individual, and may include amongst other: contact information (name, home and business address, telephone, email addresses); personal information (date of birth, citizenship, pictures, electronic identification data such as cookies, IP addresses and passwords) professional and employment information (education and training), financial details (tax identification and bank account number). There is no reference to the data derived from the submitted soil sample. Other laboratories apparently do not post publicly their personal data privacy policies [e.g. [A&L Canada](#)]. The farm group representatives, however, indicated to us that with the growers being the owners of the data there is a requirement to follow the above-mentioned transparency in the data collection process.

Stakeholder input

This project did not hold a formal consultation for stakeholders to help define parameters of the project, including its objectives and its spatial scale. Stakeholder partners, specifically farm organization and their members, may have been more likely to participate in the project if they had been provided the opportunity to define a spatial scale that was useful for representing their stewardship efforts. Recommend that any project in the future hold a 45-to-90-day consultation period for interested stakeholders to provide comment and help shape the project objectives and parameters.

Ensuring Meaningful information is coming this project

During this project, stakeholders agreed there is a need for meaningful data; however, they highlighted that we need to be considerate of the current privacy laws and data ownership. Implementing a project that only collects data from growers who are soil sampling and doing correct best management practices will not, however, provide a full representation of a region. Data collecting methods such as surveying that allow a grower to “opt-in” have the potential to skew data since growers with non-optimal levels of soil health parameters may be less likely to participate.

Ensuring data confidentiality

One key component of any data collection project will be ensuring data confidentiality. This was identified early on during the consultation process and, although, the proposed process (and that used in the Soil Test Summary) does not involve disclosure of personal data at a staff or public level, there was apparent sensitivity from stakeholders that individual data would need to be collected to construct sub-provincial aggregated information.

Other similar projects which use a third-part aggregator do not receive any personal information about the farm submitting the sample to the laboratory, other than the state or province of the farm. If there is a requirement that participating growers sign agreements with the data aggregator to acknowledge that they recognize how their data is being aggregated and utilized, the project is not likely to be successful. On the other hand, if farm groups can identify a spatial scale that they would consider useful for demonstrating the trends in soil data, there is no reason soil test laboratories could not share data in a similar manner, identifying only the spatial unit from which the soil sample was taken, not the specific farm.

Example Projects to Pull From

Below are a few examples of projects which have set out to do similar work as the Ontario Soil Test project. These examples will be beneficial to reference where there is potential data and overlap to be set

Ontario Agri-Model Farm Survey: Multi-watershed nutrient study (Agri-Model): Approximately 200 farms in 11 Quaternary sub-watersheds across southern Ontario were surveyed and shared soil test information. The survey asked questions specifically on the grower's current tillage practices and fertilizer/manure application and rates, yields, and technology adoption. Growers who complete the survey are also asked to provide a recent soil test result for their fields showing P, K and OM.

The main goals of this project were to showcase how farmers have improved, to better inform policy in Southwestern Ontario, and set best practices for agriculture-related data collection. A report is due out soon and with one of its main goals of setting best practices for agriculture-related data collection, we hope to be able to pull from its recommendations towards the larger provincial wide efforts.

Growers participating in this project were provided with a non-disclosure agreement signed between them the Research Associate and the Lead investigator. When in consultation these agreements were put in place over the course of the 3-year project with the research associate moving from farm to farm making an in-person interaction with each grower to achieve their trust and knowledge on the project. This ultimately costly but effective in ensure there is full consent and understanding from the why and what the data is being collected for.

Fertilizer Use Survey Data: (Fertilizer Use Survey)³ The Fertilizer Use survey was established in 2015 and currently collects data on grower application on fertilizer in Ontario. Annually in Ontario, the survey goes to 500 growers surveying on their practices for 2 crops (corn and then alternating years between winter wheat and soybeans).

The survey current presents data broken down by postal codes in Western/Central Lake Erie basin vs the rest of Ontario (figure 1.) The break down on this level with the survey of approximately 500 growers allows there to continue to be statistically significant data while maintaining grower confidentiality.

³ <https://fertilizercanada.ca/resources/cdn19-fertilizer-use/>

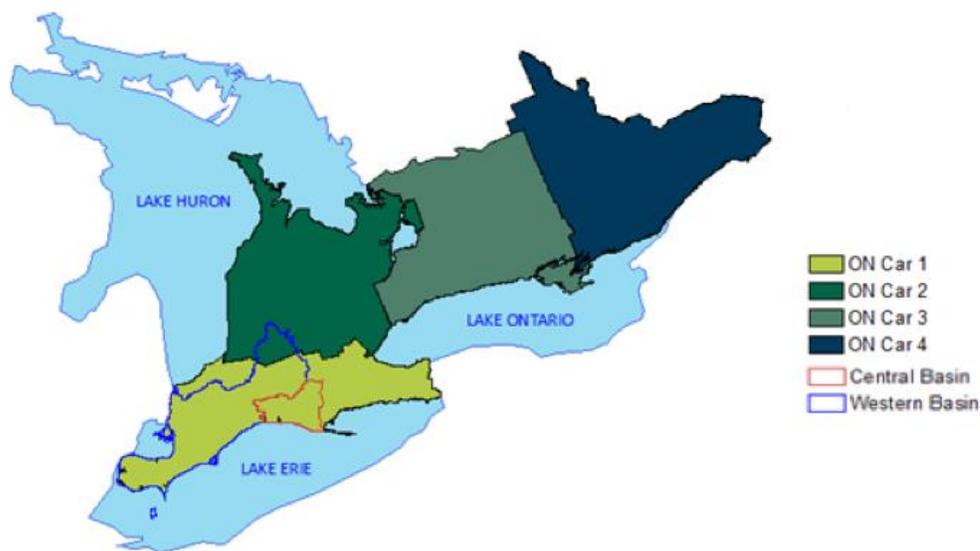


Figure 1 Taken from the Fertilizer Use Survey 2019.

Within the regions the regions in the map there are the following crop areas ⁴

- ON Car 1: 3,435,217 ac
- ON Car 2: 2,919,108 ac
- ON Car 3: 1,000,120 ac
- ON Car 4: 1,326,560 ac

To meet confidentiality requirement, growers are shown a letter prior to completing the survey which indicates “We will represent your views accurately, and we will never distribute your name or contact information. Our clients do not see any information that identifies you, so this is your opportunity to provide candid and confidential feedback.”. There is also a portion of the letter which indicates the intent of the survey process “Your feedback will be used by the industry to improve fertilizer application practices.” Growers selecting to move forward in the process are acknowledging they have read the pre-ample and are consenting their data be shared in away which is aggregated and de-personalized their information.

⁴ http://www.omafra.gov.on.ca/english/stats/census/cty32_16.htm

North American Soil Test Summary (TFI, 2021) ⁵ A survey of soil test laboratories has been conducted approximately once every five years since 1968. Summary statistics including median, percent below critical, and charts of distributions are presented for each state and province. The process used for this effort recognizes contributing laboratories but does not disclose information related to any one laboratory's volume. Labs are requested not to provide information linking samples to any particular farm, and no individual farm data is disclosed. Recent surveys in 2015 and 2020 each included over 7 million samples across North America, and over 100,000 of them from Ontario.

The project's documentation notes that despite efforts to conduct the summary comprehensively and consistently, weaknesses exist in the summary process due to the diversity and dynamic nature of soil testing services:

- It is likely that the better managers regularly test their soil and that their results may not be representative of those that do not soil test.
- The percent of samples in the summary from manured fields could vary over the years owing to nutrient management regulations that mandate soil testing. Few labs were able to separate data from manured and non-manured fields.
- Quantity of sample results is low in several states and provinces.
- Not all sample results could be definitively associated with a particular state.
- Although an attempt was made to define calibration equivalency for each of the soil test categories among the various testing procedures, it is likely that error was introduced in this process.
- Some laboratory data were submitted using categories other than those specified in the protocol, and interpolation routines were created and used to translate between the two systems.
- Data on precise depth of sampling is not given. We assume the samples were taken at the depth recommended for typical soil fertility interpretations. In most states and provinces, this is usually the top 6 to 8 inches of soil.
- These weaknesses need to be considered in interpreting and using the results of the summary.

⁵ TFI. 2021. Soil Test Levels in North America, 2020 Summary Update. The Fertilizer Institute, Arlington, VA 22203, USA. <https://soiltest.tfi.org>

Soil test phosphorus and phosphorus balance trends: A county-level analysis in Ohio (Dayton et al, 2020): ⁶This project reported that 63% of Ohio counties had a decreasing median soil test P trend and 15% had an increasing trend of P from 1993 to 2015.

The paper collected soil data from three labs (Brookside laboratories, A&L Great Lakes Laboratories, and Spectrum Analytics) which represent most of the soil tests taken in the state of Ohio.

When collecting data, it was required there be 20 data-points from each year in order for there to be data reported in each county.

This project utilized the interquartile range approach for data analysis to ensure no undue influence of outliers. This was done on a county basis and removed approximately 0.99% of points as outliers.

The project recognized the following limitations of the approach employed:

- Data only accounted for farmers who soil test.
- Sampling was not random.
- No information regarding sampling density
- Cannot verify that submitted soil samples were agriculture samples
- No information regarding crop rotation

When looking at county data from the 2016 census⁷, we see that county crop land ranges from 5,204 acres in Toronto to 735,696 acres in Huron County. When comparing these to some of the smaller states which are examined in the TFI soil test summary, we see ones like New Hampshire, Maine, and Vermont with 93,000, 390,000 and 412,000 acres of farmland. There is also some comparison in the counties of Ohio Counties from the 2017 census on page 6 of [Changes in Ohio Farms Over the Decades](#). The smallest county in Ohio had 2200 – 348,000 acres in the largest. Potential to discuss the sample sizes and data points need in a year can hopefully be pulled from comparing both the soil test network and Ohio Phosphorus project.

⁶ Dayton, E, Shrestha, RK, Fulford, A, Love, KR, Culman, S, Lindsey, LE. Soil test phosphorus and phosphorus balance trends: A County-level analysis in Ohio. *Agronomy Journal*. 2020; 112: 1617– 1624. <https://doi.org/10.1002/agj2.20146>

⁷ http://www.omafra.gov.on.ca/english/stats/census/cty32_16.htm

Conclusions Recommendations

This project provided Fertilizer Canada and Plant Nutrition Canada with an opportunity to review and assess current and potential soil data projects in Ontario, and to offer a number of recommendations based on stakeholder comments. We believe that for any future sub-provincial soil data project to be successful in the future, Ontario government and stakeholders will need to recognize and address identified barriers. To summarize our findings, Fertilizer Canada offers the following recommendations to support future sub-provincial soil data collection to assess nutrient management and soil health in Ontario.

Recommendations:

1. Any follow-up project which is funded by the government should first have a discussion paper issued by the government.

As already discussed in this report, one significant barrier was the transparency regarding the intended use of the data. If growers are going to feel comfortable with data being shared with the public, they are going to need a level of certainty as to how the data will be shared and utilized. Any future projects focused on data collection which are funded and considered property of the government of Ontario will require a clear motive and objective by the government. A discussion paper with proposed actions followed by a call for proposals would be the best recommended process to overcome this barrier and relieve concerns. This course of action would allow an opportunity for comment from any sector who has concerns, inputs into project design, and for appropriate parties to identify themselves as project collaborators

2. Explore potential data collection opportunities: leveraging existing data, surveying, and collecting data on a grower by grower basis.

Currently several opportunities remain for industry to participate in the collection of soil test data. One possibility that we briefly explored was leveraging data that currently exists via other similar projects. As discussed in the above sections of this report, there are a few provincial projects currently underway that could offer soil test data that could be collected and displayed in an aggregated form. The Ontario Agri-Model Survey is one example that worked to establish soil test level data within 11 different watersheds in Southern Ontario. This work did require time and effort to establish a relationship between growers and program administrators, and there was a cost associated with collection of the soil data (growers were given the option to have new samples taken by the research associate or they would pay a stipend per sample provided to the project). There is the opportunity to potentially utilize this data that was collected under a previous consent form and agreement.

Farm group stakeholders noted that an opportunity exists to utilize aggregated, anonymized data from the regulatory Nutrient Management plans/strategies that are submitted to the province. Although not all operations are required to submit, and thus these data from regulated farms does not represent all farms, there is an opportunity to compare distributions to the province-wide data reported in the Soil Test Summary cited above.

There is also an opportunity to survey Ontario growers. Fertilizer Canada currently leads the Fertilizer Use Survey project through a third-party firm, Stratus Ag Research. As mentioned previously, this survey collects data from 500 growers in Ontario on an annual basis to assess their management of nutrients. There are currently a number of questions in the survey to assess frequency of soil sampling practices. There is an opportunity to ask all grower who select “yes” to this question (soil sampling for P and K) if they would be willing to answer additional questions on their soil test levels among the fields used for the crop in question. To expand the survey length there would be an increase in cost to provide growers with additional incentives (owing to the diverse methods of soil sampling and analysis, the multiple analytes, and the range of soil test levels within and among fields, this addition to the survey could add considerably to its length).