
Agriculture and Agri-Food Canada
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Challenges for Developing Soil Tests for British Columbia in a Changing World
Presentation by C.G. Kowalenko – AAFC, Agassiz
at Pacific Regional Soil Science Society Spring Workshop
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Canada

Table of Contents

Issues and Challenges - General

Soil testing involves more than just conducting a chemical measurement on a soil sample in a laboratory. In order to evaluate the issues and challenges of soil testing in British Columbia, it is best to consider four fundamental questions, namely:

1. why soil test, i.e., what is the **purpose** and scope?
2. what is involved in soil testing, i.e., what are the **pursuits** and activities involved?
3. how is soil testing accomplished, i.e., what **processes** are involved, and how is the system assembled or structured?
4. who are the **participants** or agencies that are involved and what expertise is needed for action?

Once these questions have been considered, I will examine the system as a whole (general issues and challenges) and then focus on some specific issues related to individual nutrients or elements in British Columbia.

1. Why is soil testing conducted?

Soil testing is used to manage elements in soil for optimum crop production while minimizing the potential for these elements to pollute soil, air and water. The elements that are usually examined by soil testing are those that are required for plants to grow (macronutrients such as nitrogen, phosphorus, potassium, magnesium and micronutrients such as boron, zinc, copper) and those that can occur in the soil not required by plants but can be toxic or harmful (such as lead, cadmium, mercury). Soil tests are also conducted on factors that are associated with these elements such as pH and salinity.

2. What is included in soil testing?

The soil test system can be viewed to include five distinct but closely associated components: a. **development**, b. **implementation**, c. **utilization**, d. **promotion**, and e. **monitoring**.

a. Development

There has been substantial research conducted to establish the tests and their interpretations, however, further refinements are needed to incorporate new information and to adjust to new requirements. Research that is used to develop and refine soil tests includes basic scientific knowledge, correlations of sample chemical analyses with plant response data and calibrations under broad field conditions. Although scientific knowledge about elements in soil and plants is critical, general scientific advances, especially development of chemical analysis methods and instrumentation, can contribute to improving the system. Although soil tests have been developed from correlations between sample measurements and crop response data, these relationships may be based on empirical (mathematical) or mechanistic (basic biological or chemical) relationships. Since correlations are usually conducted in growth chambers, greenhouses or small-scale field plots where experimental conditions are controlled to facilitate interpretations, larger field calibrations are also conducted to extrapolate to more complex soil, crop and weather combinations that would occur naturally. After the soil measurement and crop response relationships have been determined, practical interpretations (i.e., recommendations) are derived. These interpretations will vary with the purpose or philosophy for the test. Philosophies that have been used for fertilizer recommendations include sufficiency, build and maintain or cation saturation concepts (e.g., see Pellerin et al. 2006).

b. Implementation

To have effective soil tests, it is critical that the sample that is chemically analysed has been taken to represent the field accurately and the sample handled properly. After the chemical analyses are completed, the values need to be interpreted and a recommendation given.

c. Utilization

Soil tests can be used for a variety of purposes, although they have primarily been developed for crop producers (farmers, growers). Increasingly, soil tests are being used for environmental protection in addition to production of crops. There are various intermediates that are involved to provide service, consultation and marketing information. Scientists also use soil test analyses for a variety of purposes.

d. Promotion

The soil test system also requires promotion. This could include general education (e.g., how to take a sample) or promotion (e.g., addressing public concerns) and specific business advertising.

e. Monitoring

In order for these components to work as a system, monitoring is required to examine its efficiency and effectiveness to determine whether changes are required. Monitoring could also include an examination of historic data to determine trends of nutrient contents in the soil in relation to crop production and environmental impacts.

3. Who is involved?

A number of participants and agencies make up the soil test system, in addition to those required to conduct the chemical analyses on the soil samples. Different types of expertise are required for each activity. The participants or agencies include researchers, laboratories, consultants, users and consumers.

a. Researchers

Researchers could include scientists who work for public agencies (such as government or university) or privately (such as consultants or business staff). Researchers are particularly involved in development of soil test procedures and also for monitoring.

b. Laboratories

Once soil test methods have been derived, laboratories require technologists and chemists to conduct the analyses on the samples submitted. Laboratories may be operated by government, university or a private agency.

c. Consultants

Consultants can be those that provide advice about how to obtain and submit samples, and how to interpret the results of the test. Advisors may belong to public (e.g., extension agents) or private (e.g., laboratories, dealers, consulting business) agencies.

d. Users

Although soil testing was largely developed to provide a way for growers to determine if nutrient amendments are required for crops, it is also used by other participants for a variety of purposes. Users could include farmers, fertilizer dealers, consultants, researchers and environmentalists, working for either public or private agencies.

e. Consumers

Consumers or the general public usually do not use soil testing, but they can derive benefits, both directly and indirectly. Benefits could include low cost food of high quality and an environment that is not polluted during the production of food.

4. How does the system function?

Soil testing involves a number of pursuits and activities that are connected in a system that involves participants of different expertise and who belong to a variety of public and private agencies.

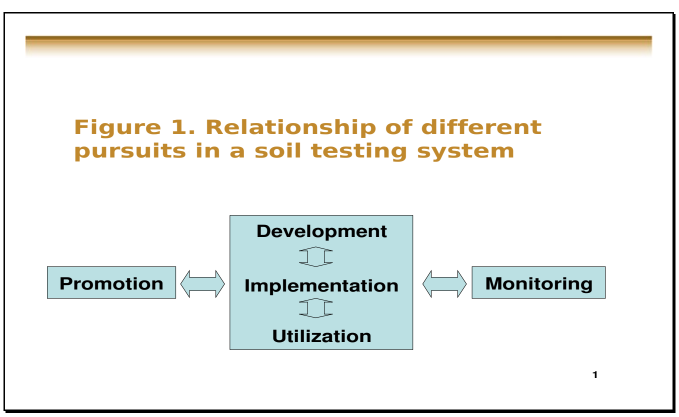


Figure 1 shows how the different pursuits interact. Development, implementation and utilization tend to be the core activities, with promotion and monitoring being conducted more generally on the system as a whole.

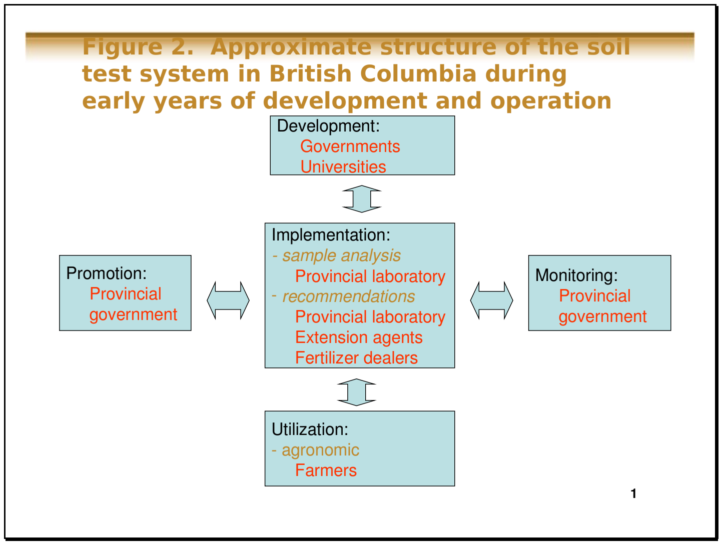


Figure 2 shows a schematic of how the soil test system functioned during the early days of the system when the activities were centered around a single laboratory operated by the provincial government. The primary participants were federal and provincial government and university agencies and individuals focused on providing a farmers with recommendations for applying nutrients as fertilizer or manure for optimum crop production (i.e., use for agronomic purposes).

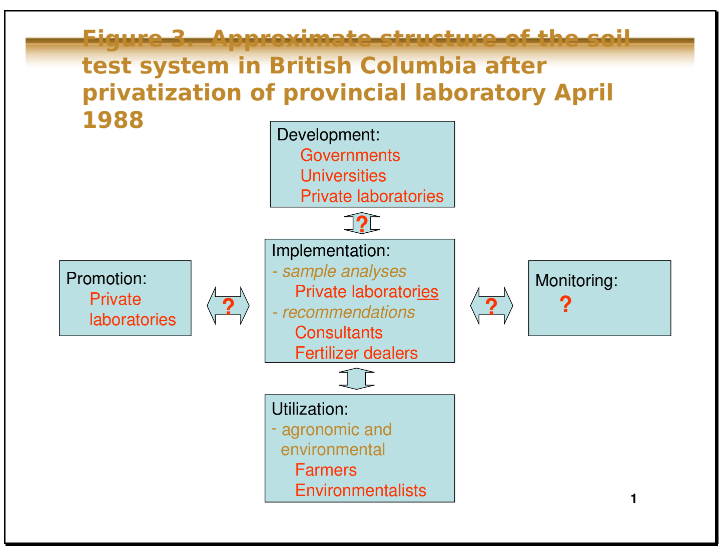


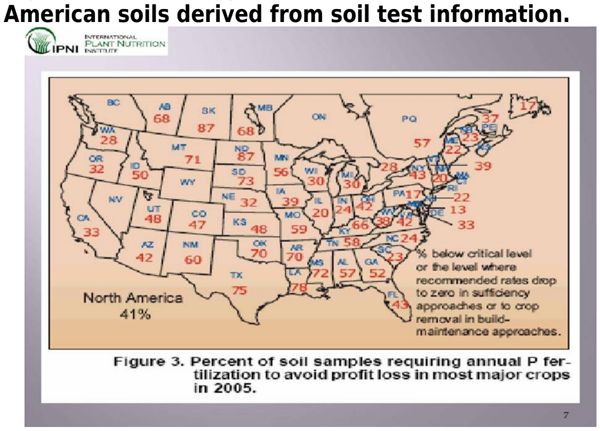
Figure 3 shows how the system changed when the provincial laboratory was privatized in early 1988. Although private laboratories were functioning prior to the privatization of the provincial laboratory, leadership for soil testing and recommendations was dispersed to numerous agencies and individuals, and relationships of agencies and individuals became informal after the privatization. The role of public (government and university) agencies and individuals, especially regarding development, promotion and monitoring activities became undefined. At about the time of the privatization, environmental issues of nutrient management were becoming more important in relation to agronomic considerations.

Several critical questions in relation to the current structure of the soil test system in British Columbia include:

- Is the current soil test system adequately coordinated?
- How can new procedures and interpretations be incorporated in the current system?
- Is the current system suitable for environmental uses?
- Can the current system be used for policy and regulation development and implementation? Can standards be established?
- Is there adequate capacity and expertise to maintain and enhance the system?
- How should plant tissue testing be coordinated with soil testing?
- Is there adequate promotion about and monitoring of the system?

Figure 4 shows a summary of the agronomic status of phosphorus in North American soils in 2005. Notice that there is no data for British Columbia, largely due to the lack of a way to collect data from the private laboratories that serve British Columbia.

Figure 4. A summary of the status of P in North American soils derived from soil test information.



From a presentation by Tom Jensen (International Plant Nutrition Institute) at Western Canadian Phosphorus Workshop, Winnipeg, 21 November 2007.

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Issues and Challenges – Nutrient/Element Specific

The above examined general issues and challenges related to the soil test system in British Columbia, now a few comments will be made and questions posed about issues and challenges for soil testing of specific nutrients especially nitrogen and phosphorus.

1. Nitrogen

For many reasons, nitrogen has defied development of soil tests similar to those for phosphorus and potassium. It is only recently that a nitrogen soil test has been proposed for British Columbia soils (see Kowalenko 2000). The basis of the test has been the measurement of nitrate. Although this measurement has been promoted, there are a number of questions about its effectiveness and applicability, including the following:

- Is this specific measurement and interpretations from the values adequate for distinguishing deficient versus excessive situations, for all types of crops and for all areas of the province?
- Are current recommendations suitable especially in relation to time, depth, spatial location, and handling and storage of the sample?

2. Phosphorus

There are a number of questions about phosphorus soil tests, both generally and specifically for British Columbia including:

- Are methods being used to quantify this element in the extracts influencing the interpretations?

  Recent work has shown that the most commonly used colorimetric method to measure phosphorus for soil testing has serious interference problems (see Kowalenko and Babuin 2007). Also, a frequently used alternative measurement (inductively coupled plasma) measures both organic and inorganic phosphorus, and it is not known whether both of these forms of phosphorus are equally available to crops (see Kowalenko 2008).

- Are current interpretations of phosphorus tests adequate for both agronomic and environmental purposes for British Columbia?
- What extraction methods or methods (e.g., Bray, Kelowna, modified Kelowna, Mehlich-1, Mehlich-2, Mehlich-3, Olson, Morgan ...) should be used in British Columbia?
- Should other elements (e.g., aluminum, iron, calcium, magnesium) or texture be measured to enhance interpretations of phosphorus measurements?

3. Other nutrients

- Are soil tests adequate or available for other nutrient elements (e.g., potassium, magnesium, sulphur, iron, manganese, boron, copper, zinc, molybdenum) for distinguishing both deficient and excessive situations in British Columbia?

See Kowalenko and Neilsen (1992) and Kowalenko (1993) for background information.

- Should soil tests be developed for other (non-nutrient) elements?

Some examples to consider are:

- aluminum in relation to soil pH/reaction,
- sodium in relation of salinity or alkalinity,
- carbon in relation to global warming/sequestration and soil quality,
- selenium in relation to human and animal health, and
- toxic elements such as lead, arsenic and cadmium especially in relation to increased use of organic and other elements.

Acknowledgement

Most of this material was presented at a meeting of a newly constituted British Columbia Soil and Tissue Testing Council in Langley 23 October 1990! The Council operated to about 1993. The title of the presentation was "Components of a Soil and Tissue Testing Program".

References

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