

Roots of sustainability: A comparison of long-term crop soil health studies

By Dirk Uys, Potatoes SA

“The soil microbiology is the workhorse of the soil.” Prof Bob Larkin

During the 31st annual Soilborne Plant Disease Symposium hosted in Stellenbosch in 2023, Prof Robert (Bob) Larkin from the United States Department of Agriculture shared his insights into the suppression of soilborne diseases in potatoes through crop rotation. Prof Larkin is based in Orono, Maine and visited South Africa as a guest of well-known vegetable producer, ZZ2. Prof Larkin is a potato plant pathologist who focusses on the soil health of potato production systems.

A visit to Petrus Steyn

During his stay, Prof Larkin along with Wiam Haddad from ZZ2, visited the Potatoes SA long-term crop rotation trial in Petrus Steyn. This project, which is being conducted under the auspices of Prof Martin Steyn of the University of Pretoria, has been showing a similar trend to the work done by Prof Larkin in the United States (US). The similarities serve as proof that multiple rotation programmes do in fact benefit favourable soil organism systems which create disease suppressive soils. It must, however, be recognised that this journey takes time.

His research highlighted the challenge presented by pathogens such as *Rhizoctonia* spp., *Fusarium* spp., *Sclerotinia* spp. and *Verticillium* spp. and their negative impact on potato quality and yield. Crop protection products offer control against specific diseases. Different potato varieties provide varying levels of disease tolerance. To provide future control strategies, Prof Larkin's research emphasises

the essence of creating a disease suppressive soil by providing an environment in which it is difficult for a pathogen to establish.

Researchers at the Petrus Steyn Potatoes SA long-term rotation trial started noticing an increase in beneficial organisms in the soil. This includes the establishment of beneficial nematode populations as well as indications that rotation treatments can support a population of biological control agents, resulting in a reduction of sclerotia hypocotyl infections in a maize-soya beans-maize-fallow-potatoes-maize rotation system.

Early findings from this local soil health analysis suggest that the inclusion of cover crops in the rotation system has already improved soil microbial diversity and functionality of the soil. Healthy soil is considered stable soil, high in biological diversity with high levels of internal cycling of nutrients.

Outcomes from US-based studies

In Prof Larkin's studies he compared different hypotheses:

- A basic rotation system consisting of a two-year rotation with barley.
- A soil conservation system consisting of barley, canola and rye.



From the left are Anjé Erasmus, Potatoes SA regional co-ordinator, Dirk Uys, research and innovation manager at Potatoes SA, Wiam Haddad of ZZ2 Ecosystem Services who hosted Prof Larkin, Gert Bester, chairperson of Potatoes SA, and Prof Bob Larkin, United States Department of Agriculture.

- A soil improvement system consisting of compost with barley and canola.
- A disease suppressing system consisting of mustard and barley.
- A continuous potatoes system.

Key outcomes from his work show the value of a focus on creating improved soil, but it is important to note the following:

- The benefits of crop rotation systems do take time. The goal is ultimately to create a soil environment that will establish suppressive soils that slow down the development of diseases.
- Soil health is difficult to define but it does aim to sustain biological productivity, which promotes plant health.
- Crop rotation will replenish soil health by maximising diversity in crop selection which:
 - o Breaks disease cycles.
 - o Benefits physical, chemical, and biological profiles that stimulate biological activity, creating competition which suppresses the pathogen.
 - o Stimulates production of biological compounds that inhibit the target pathogen. This includes bio-fumigation where plants such as Brassicas create metabolites that are toxic to specific pathogens when they are degraded in the soil.

Prof Larkin's research shows that the incorporation of plant material to promote soil health by including crop rotation, cover crops and green manure crops, organic amendments and conservation tillage, does benefit the soil's physical, chemical, and biological properties. Although these management practices will not eliminate diseases, it will certainly reduce it, thus enhancing the long-term sustainability of potato production.

In it for the long run

It was valuable to learn that this research mirrors the existing work done on potatoes in South Africa. Bearing in mind that an investment in soil health is a long-term investment, we do need to take note that pressure on traditional control measures is here to stay.

The integration of control strategies with agronomic systems will become more relevant in future. However, this change will require bold steps combined with a better understanding of the positioning of multiple control strategies adapted for each farm to optimise a return on investment for potato producers. 🍅

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