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# Potato Update

Issue 10

Potatoes NEW ZEALAND
Growing together

## Year 2 of SFF project: The effects of soil quality and seed health on potato yields

FAR

### Introduction and methods

In year one of this three year Sustainable Farming Fund project a nationwide survey of 18 potato crops (Pukekohe, Manawatu and Canterbury) indicated that soil compaction and presence of soil- and seed-borne pathogens were likely to be the main factors limiting yield.

Year two of the project focused on defining the impact of seed health and soil quality on potato crop performance. This required careful management of potential sources of variability (cultivar, soil type, climate and crop management). This was achieved by hosting all trials in one region (Canterbury) and planting the same seed lines in four-plots (Russet Burbank and Innovator, treated and untreated with formalin) in each of 15 potato fields. The fifteen fields were grouped into four field categories related to paddock history and soil health:

**1. Diseased** - previous potato crops within the last 10 years, **'good' soil structure** - at least 5 years grass in the 10 year history (1 field).

**2. Diseased** - previous potato crops within the last 10 years, **'poor' soil structure** - at least 5 years arable crops in the 10 year history (6 fields).

**3. Clean** - no previous potato crops within the last 10 years, **'good' soil structure** - at least 5 years grass in the 10 year history (4 fields).

4. **'Clean'** - no previous potato crops within the last 10 years, **'poor' soil structure** - at least 5 years arable crops in the 10 year history (4 fields).

Crop histories were collated for a 10 year period (2005/06 to 2015/16) for each field, and a crop score applied to each main

### Key points

- Year two of this three year SFF project focused on soil structure and rotation history for 15 sites in Canterbury. There were four-plot trials at each site (Russet Burbank and Innovator, treated with formalin and untreated).
- The major influence on yield was soil quality, and seed-soil borne disease had little impact.
- The crop history score x soil structural condition score factor explained 39% of the yield variation for Innovator and 52% for Russet Burbank. If soil quality is poor then growers should consider growing Innovator in preference to Russet Burbank.
- There was a good correlation between yield and a 10 year crop history score, and between yield and a one-off soil structural condition score, showing that these two independent methods could be useful for gauging paddock suitability for growing potatoes.
- More grass in a ten year history improved soil resilience and enhanced rooting hospitality for potatoes, thus enabling the crop to access more resources. For Russet Burbank, this equated to an average 3.5 t/ha lift in yield for every year in the previous ten year history a field was in grass.
- Formalin dipping did not significantly control these diseases in the glasshouse or the field.
- Seed could have transferred *Rhizoctonia solani*, causing stem canker, and *Spongospora subterranea*, causing root galls, to the field, as all glasshouse plants were infected with these diseases.
- Stem canker and root gall incidence and severity was greater from an ex-potato paddock history compared with no potato history, but yield was unaffected.
- Disease severity was higher in fields with predominantly grass histories, compared with mainly cropping histories. However, gross yield was greater from ex-grass (86 t/ha) than from ex-crop fields (75 t/ha).

annual crop, depending on its ability to help maintain or restore soil structure (fallow = 0, 1 = weak rooted crop e.g onions, 4 = strongest rooting crop e.g grass. Maximum score = 40). The sum of the ten crop scores made up the crop history score. Potato plant health in each plot was monitored four times during crop growth, with soil aggregate stability (testing soil impact resilience) and soil structural condition score (a visual test for root hospitality) measured once in mid-season, and final yield measured at harvest.

Whole seed from the same Russet Burbank and Innovator seed lines, either dipped or undipped in formalin, were grown out in potting mix (low disease risk) in a glasshouse to check for the presence of viable seed borne diseases. The temperature in the glasshouse was set at 16 ºC, optimal for soil-borne disease development, and there were 10 single plant replicates. No diseases were visible on the tubers at planting.

## Results

### Seed and soil health

Commercial formalin dipping had little effect on controlling seed-borne disease in the glasshouse plants, as all plants developed symptoms of *Rhizoctonia* stem canker and *Spongospora* root galls. However, Russet Burbank seed was less diseased than Innovator, and formalin slightly reduced stem canker severity, although not significantly.

Formalin dipping did not reduce the incidence or severity of the two diseases in the field trials. This meant that it was not possible to complete one of the objectives of the trial, to define the relative contribution of seed-borne and soil-borne disease to the incidence and severity of disease in the field. However, the combined effect of any seed- and soil-borne pathogens affected disease expression differently for crops in the various field categories.

The risk of stem canker incidence increased from 70% to 83% when more than five years of grass was included in the 10 year paddock history. The risk of *Spongospora* diseases increased from 24% to 73% where potatoes had been grown once before, and increased from 3% in paddocks with a mainly crop history, to 46% for paddocks with a mainly grass history (Table 1).

**Table 1.** Chance (%) of disease occurring for the diseases *Rhizoctonia* stem canker and *Spongospora* root galls, under contrasting cropping histories averaged for all 15 sites.

| Disease | Crop History | | | |
|---|---|---|---|---|
| | No potatoes in 10 year history | Previous potato crop in 10 year history | > 6 years crops | > 7 years grass |
| *Rhizoctonia* stem canker | 75 | 92 | 70 | 83 |
| *Spongospora* root galls | 24 | 73 | 3 | 46 |

### Soil physical quality

Soil from most fields with a long term grass history, i.e. a crop history score of > 28, 7 years grass, had a higher soil aggregate stability (range 1.8 to 2.2 mm Mean Weight Diameter (MWD). Based on a PFR study of 105 arable crops, these levels were over the threshold of 1.5 mm MWD needed to grow crops that are likely to at least equal the regional average yield (Figure 1a).

Soil structural condition score was closely associated with crop history score (Figure 1b). This shows that much of the improvement in the ability of the soil to provide an adequate environment for optimum potato root growth was provided by the long term grass history. This was even after the intensive cultivation used to plant potatoes, when the soil condition score measurements were taken.

Greater values of aggregate stability, soil structural condition score and crop history score all indicate improved potential root hospitality.

There was a strong correlation (P = 0.012 for Innovator and P = 0.002 for Russet Burbank) between gross yield and a factorial of crop history score and soil structural condition score. When combined, they helped to describe the influence of soil quality on yield (Figure 2). For Innovator, about 39% of the yield variation was explained by the soil physical state; whereas Russet Burbank was more sensitive to poorly structured soil, with yield increasing more strongly in response to improved soil structure (52% yield variation explained). For Russet Burbank, this translated into an extra 3.5 t/ha yield for every year a paddock was in grass during the previous ten years.

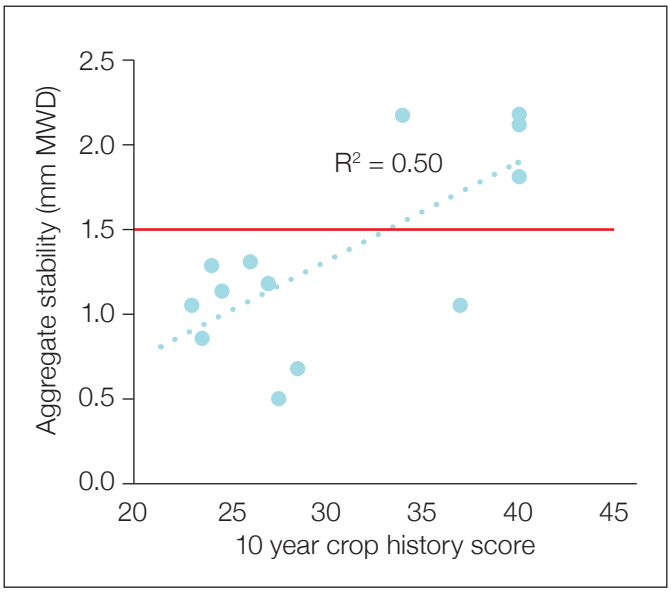


**Figure 1a.** The relationship between crop history score and aggregate stability. The greater the R2 value the stronger the relationship between the two variables. The red line is the aggregate stability value below which crops are likely to yield below the regional average.

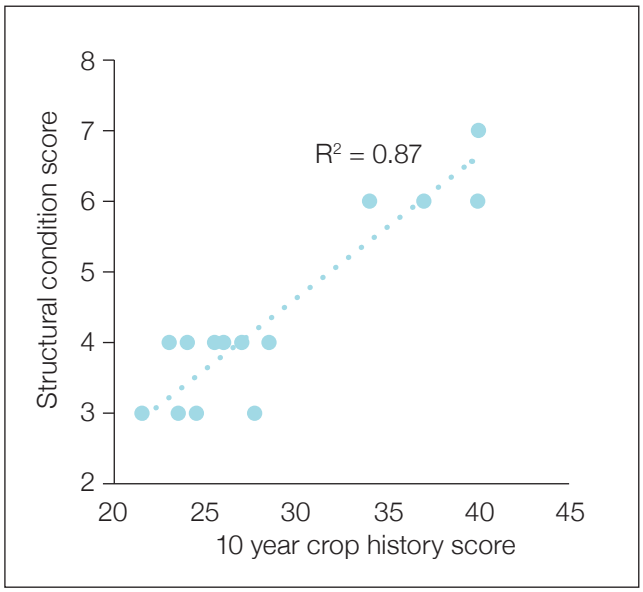


**Figure 1b.** The relationship between crop history score and soil structural condition score.

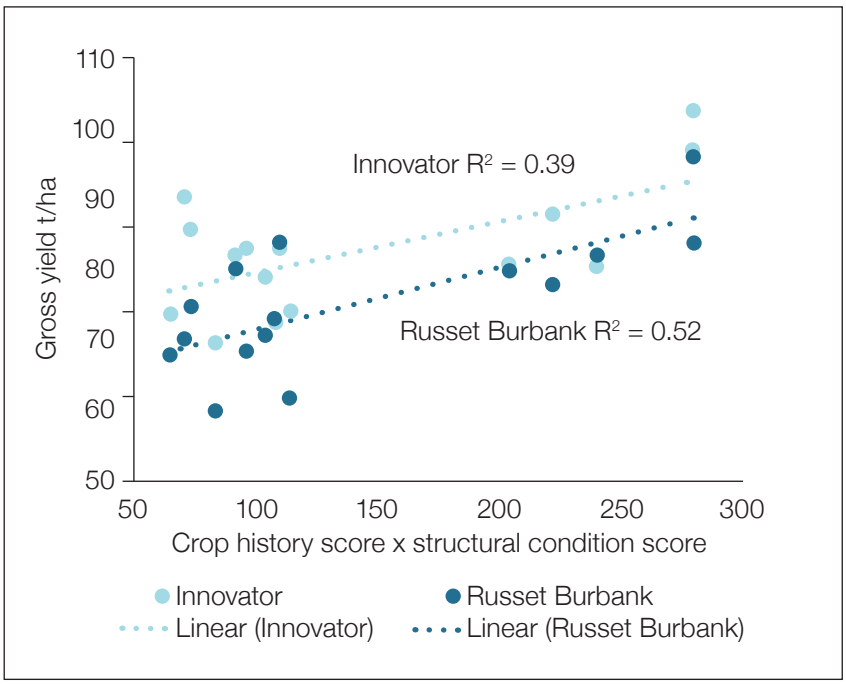


**Figure 2.** The relationship between a factorial of crop history score and soil structural condition score and gross yield. The greater the R2 value the more of the yield variation that can be explained by the physical state of the soil.

### Potato yield

For marketable yield, Innovator yielded 81 t/ha, ($P$ = <0.001), 14t/ha more than Russet Burbank (67 t/ha). Irrespective of cultivar, potatoes grown in ex-grass fields yielded more (79 t/ha, $P$ = 0.024) than those grown in ex-crop fields (69 t/ha). Yield was unaffected by formalin treatment and whether or not potatoes were one of the crops in the cropping history.

## Summary

This year research aimed to determine the influence of crop history, soil quality and soil/ seed-borne disease on potato yield. Results indicated that improvements in soil structure, resulting from a grass-dominant history, were synonymous with higher yields. This was despite that fact that soil-borne disease incidence was higher in the

ex-grass fields. This indicates that more emphasis could be placed on scrutinizing cropping history and soil structural quality, before selecting a particular field for growing potatoes.

Disease risk also increased in paddocks where potatoes had been grown in the last 10 years, but this factor did not result in reduced yield. Formalin dipping of seed did not assist with seed-borne disease control, and all seed used in the experiment had a high incidence of disease present. Further investigation is needed to determine how seed health may be limiting yield potential.

In the final year of this project, we hope to explore the link between crop history, soil physical quality and potato yield for a wider range of crops in major potato growing regions. Extension will also be a major focus. We will look at developing or refining field soil tests and/or calculators or apps, along with information packages to quickly inform a grower of the physical state of a paddock prior to sowing the crop.

## Acknowledgments

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