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## Conservation practices and longer rotations make a difference: Higher potato yields and healthier soils!

*Rotations four years or longer, combined with conservation management practices, including compost, can result in increased potato yields and improved soil quality*

### BACKGROUND:

Crops that are commonly irrigated in southern Alberta, such as potatoes, sugar beets and dry beans, produce little crop residue that is returned to the soil.

Growing these crops in tight rotations may have long-term detrimental effects on soil quality, and increase the risk of erosion as well as the prevalence of disease or pest problems.



Potato plots at Vauxhall, Alberta

Researchers at Agriculture and Agri-Food Canada (AAFC) in Lethbridge, Alberta, initiated a 12 year irrigated rotation study to assess the impact of different rotation lengths as well as conventional versus conservation management practices on potato yield and quality, on the propensity for disease and pest problems, and on soil quality. A long-term study with multiple repetitions of each of the rotations was required to take into consideration that the short-term performance of a given crop rotation system may not reflect its performance over the longer term. The Potato Growers of Alberta supported this work as they were looking for answers they could rely on, as growing and processing potatoes is a \$1billion a year industry in the Province.

### THE STUDY:

The 2000 -2011 study was conducted at the AAFC Research Farm in Vauxhall, Alberta, and was led by soil scientist, Dr. Frank Larney in collaboration with Dr. Bob Blackshaw, a weed scientist at Lethbridge.

The study involved combinations of four main crops, potatoes, sugar beets, beans and soft wheat, grown in three, four, five and six-year rotations. Timothy was also grown for two years in the six year rotation; continuous wheat was grown every year, as a baseline (Table 1).

Canada

**Table 1: Long term rotation study**

P: potatoes; W: soft wheat; B: beans; SB, sugar beet; O(t): silage oats - harvested July, timothy seeded August.; T: timothy, Conv: conventional; Cons: conservation

Length of Rotation, year	Rotation	Management practice
1	W	
3	P-B-W	Conventional (3-Yr Conv)
3	P-B-W	Conservation (3-Yr Cons)
4	P-W-SB-B	Conventional (4-Yr Conv)
4	P-W-SB-B	Conservation (4-Yr Cons)
5	P-W-SB-W-B	Conservation (cereal breaks) (5-Yr Cons)
6	P-O(t)-T-T-SB-B	Conservation (forage break) (6-Yr Cons)

Each of the 26 variations appeared every year and was replicated 4 times, for a total of 104 plots. Each of the plots was approximately 10.1 m by 18.3 m, had similar growing conditions, and were irrigated as required.

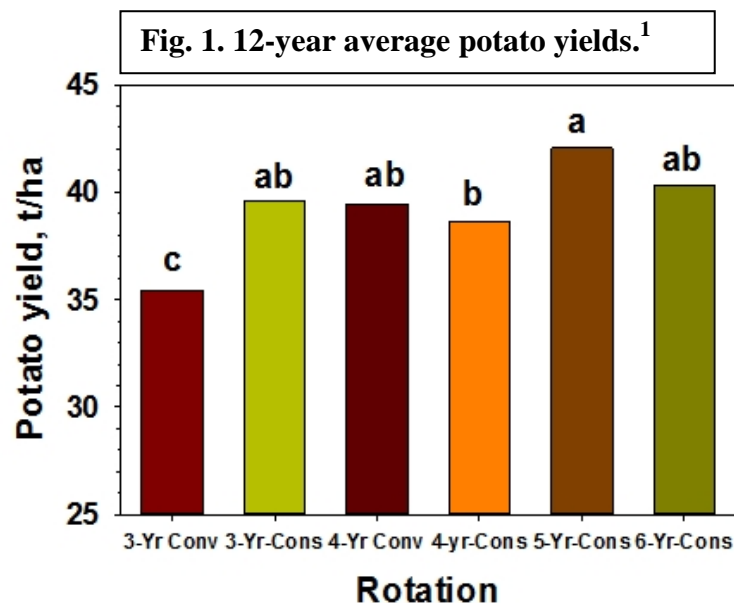
The conservation rotations included four specific management practices:

- Direct seeding/reduced tillage where possible (e.g. for conventional practices, used mouldboard plowing for potatoes; for conservation practices, used disking for potatoes)
- Fall-seeded cover crop (fall rye after potatoes and before beans/wheat, and also after beans and before wheat)
- Composted beef cattle manure was applied at a rate of 28 or 42 tonnes/hectare (wet weight) every third year, before the potatoes were planted. No inorganic phosphorus fertilizer was applied and inorganic nitrogen fertilizer was cut to 33% of that used under conventional management practice.
- Where beans occurred in the rotation, solid-seeded narrow-row (25 cm) straight cut beans were planted versus conventional wide row (60 cm) undercut beans.

## **KEY FINDINGS:**

### **MARKETABLE YIELD**

The average marketable potato yield from the three year conventional Potato-Bean-Wheat (3-Yr-Conv-P-B-W) rotation was significantly lower (35.2 t/ha) than for all the other rotations (yields for the other rotations ranged from 38.6-42.0 t/ha) and 12% lower than the 3-Yr P-B-W rotation using conservation management practices (3-Yr-Cons P-B-W).



<sup>1</sup>. Bars with the same letters are not significantly different from each other 19 times out of 20

Simply lengthening the rotation to four years while maintaining conventional practices increased potato yield by 11% (4-Yr-Conv versus 3-Yr-Conv). There was no significant yield benefit from using conservation practices if the rotation length was four years (4-Yr-Conv vs. 4-Yr-Cons). Potatoes grown in the 5-Yr conservation rotation with a “cereal break” (row crops in years 1, 3 and 5; cereals in years 2 and 4) yielded 18% higher than the 3-Yr-Conv rotation, and 10% higher than the 4-Yr-Cons. However, stretching the potato rotation to one year in six did not lead to a significant yield increase except over the 3-Yr-Conv rotation where yields increased 14% (Fig. 1).

## QUALITY FOR PROCESSING

Since approximately 80% of the potatoes grown in Alberta are processed, the specific gravity of potato tubers is an important quality criterion. This study found no significant effect of rotation on the specific gravity of the harvested potatoes when averaged over the 12 year length of the study. However, there was a declining trend in specific gravity as rotations lengthened, from 1.08475 on the 3-Yr-Conv to 1.07954 on the 6-Yr-Cons (Fig. 2).

## CONVENTIONAL VERSUS CONSERVATION PRACTICES

Overall, potatoes grown with conservational management practices (3-, 4-, 5- and 6-Yr Cons) had a 7% higher marketable year and a slight 0.164% decline in specific gravity (from 1.08353 to 1.08053) compared to potatoes grown with conventional management practices (3-, 4-Yr Conv) (Fig 3a and 3b).

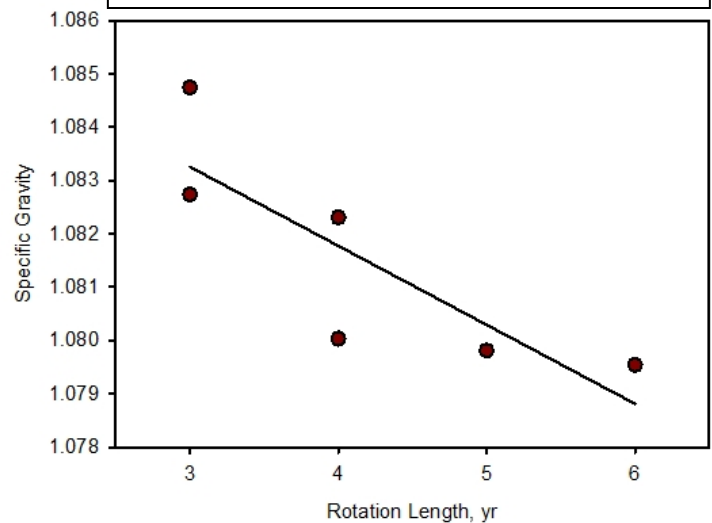
## LENGTH OF POTATO ROTATION

The longer rotations (4-Yr- Conv, and 4-, 5- and 6-Yr-Cons), also had a significant 7% increase in average marketable yield, and a slight decline in specific gravity (from 1.08375 to 1.08042) compared to the three year rotations (3-Yr-Conv, 3-Yr-Cons) (Fig. 3a and 3b).

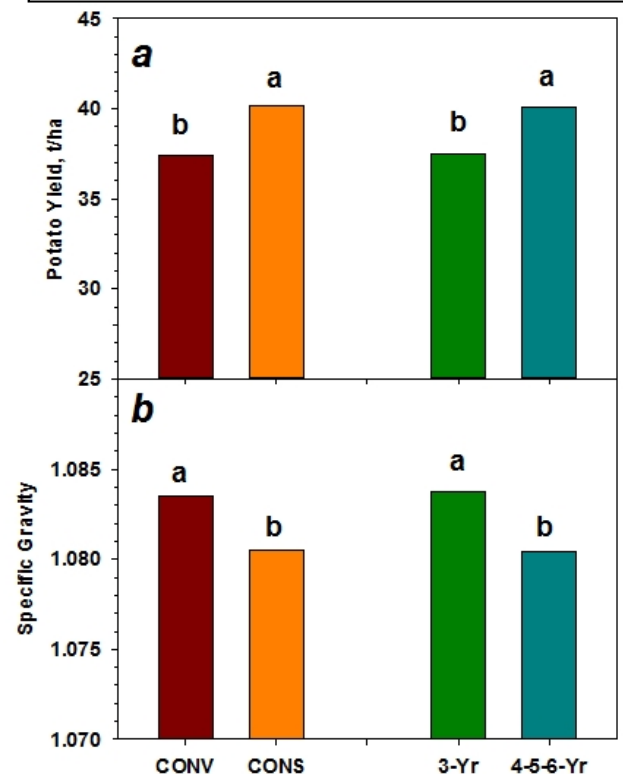
## ECONOMICS

Data from the study are currently being evaluated to determine the economic affects of the various crop rotation and management practices. (i.e. Does the higher yield obtained with conservation management offset the cost of extra inputs (e.g. compost, cover crops) in these rotations?) The results of the detailed economic analysis will be shared when available.

**Fig. 2 Specific gravity vs. rotation length**



**Fig. 3 Effect of rotation management and short vs. longer rotation length on:**  
(a) 12-yr average potato yield  
(b) 12-yr average specific gravity

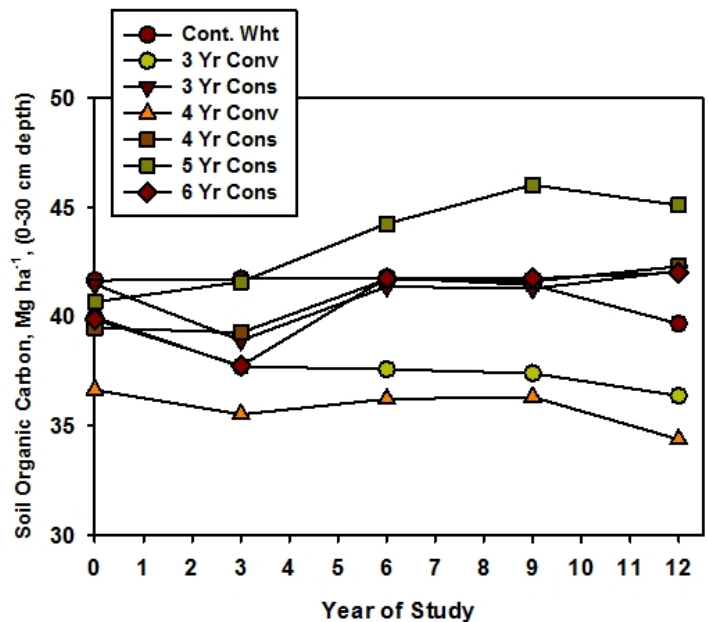


## SOIL QUALITY

The study confirmed the benefits on soil quality of using conservation management practices such as no till, direct seeding, fall cover crops, and applying composted manure every third year. The plots managed with conservation practices showed significant improvements in soil quality parameters such as organic carbon, microbial biomass and aggregate stability. Soil organic carbon also increased or was maintained throughout the 12 year study period in the 0-30 cm soil depth (Fig. 4).

For example, soil organic carbon in the five year conservation rotation increased 11% over the 12 years. This increase was largely due to the addition of compost every three years. In comparison, soil organic carbon in the three year conventional rotation, decreased 9% over the 12 years. Over the long term, this declining soil quality will have an impact on potato yield. Increasing soil organic carbon is important for maintaining and improving soil fertility, soil structure, and soil physical properties such as water holding capacity, water infiltration, root growth, and ease of cultivation.

**Fig. 4. Effect of rotation and management on soil organic carbon over time**



## VERTICILLIUM WILT

Potatoes grown with conservation management were less prone to potato early-dying syndrome (*Verticillium* wilt) which may suggest that the compost applications may inhibit the risk of infection. However, this was not consistent in all years and warrants further investigation.

## THE BOTTOM LINE....

Growing potatoes in three year rotations (potatoes-beans-wheat) without conservation practices is not recommended due to significant yields declines of 12-18% over the long-term. Overall, conservation practices and rotations that were four years or longer resulted in higher marketable potato yields (7% increase) and significantly improved soil quality.

### For more information go to:

Larney, F. J., D C. Pearson, R. E. Blackshaw, N. Z. Lupwayi, and P. J. Regitnig, 2012, What have we learned about potatoes in the 12-yr Vauxhall Irrigated Rotation Study?, Potato Growers of Alberta Annual Meeting, Red Deer, AB. Nov 13-15, 2012.

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