The Glenlea Study: Celebrating 30 Years

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Glenlea was named after the Scottish home of the region's first postmaster, C. H. McWatt, in 1891. Located 20 km south of Winnipeg, Glenlea lives on Treaty 1 territory, the ancestral lands of the Anishinabek people and home of the Metis Nation.

Looking north from the post office and the church, the only buildings left to mark the former hamlet, visitors can see a small wooden building, some newly planted trees, and crop plots neatly arranged across the landscape. This is the Glenlea long-term crop rotation study. Started in 1992, the Glenlea study is Canada's oldest organic field crop study. This year, we are celebrating the study's 30th anniversary.

The main feature of the Glenlea study is two different crop rotations that are managed both organically and conventionally. Rotation 1 includes grain crops in a rotation of wheat-flax-oat-soybean (green manure instead of soybean in the organic system). Rotation 2 includes both forages and grains in a rotation of alfalfa hay for two years, followed by wheat, then flax. The organic plots are split. In one half, we apply composted cattle manure to replace exported nutrients. The other half of each organic plot receives no supplemental nutrients.

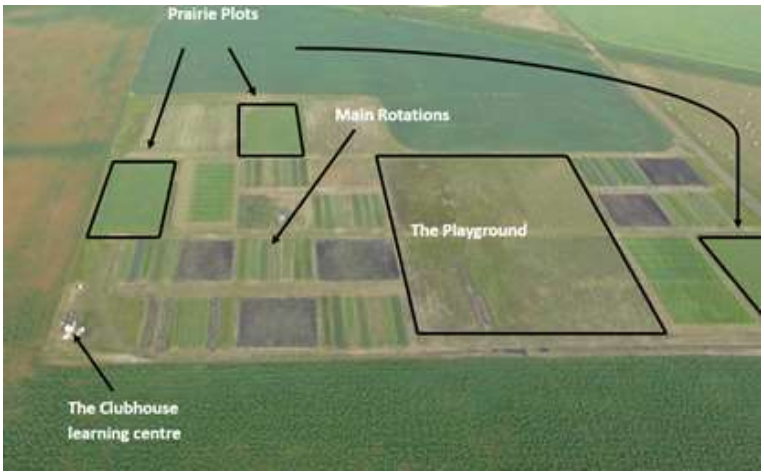

Photo credit: Gary Martens

Glenlea's second feature is the one-acre plots of restored prairie grassland, one located in each of the study's three replications. The grassland, which was seeded in 1993, includes native species of wheatgrasses, switchgrass, big bluestem and Indian ricegrass. These grassland plots serve as a benchmark and allow us to study the question "Can agricultural soils be as healthy as perennial grassland soils?"

Glenlea's third feature is the "playground", 5 acres for conducting various experiments under organic management. "Playground" experiments in 2021 include: Yield trials for AAFC Brandon, Manitoba's organic oat breeding program; Yield trials for the U of Guelph's organic soybean breeding program; a PhD student's oat-legume intercropping study; and weed control experiments using green manures and new robotic weeding equipment.

Wind, wind, wind seems to be a constant feature of Glenlea. To allow students, technicians and visitors to get out of the wind, we added a “Clubhouse” in 2008. It was built by 5 high school students under the supervision of James Frey, then UM technician. In the spirit of organics, most of the lumber was repurposed from various demolition sites and the building’s siding is made of poplar wood harvested near Beausejour, Manitoba. The screen porch is handy during mosquito season, and the firepit is an inviting feature on cold September mornings.

A gathering of students and staff at one of Glenlea’s many field schools

The People

People are the most important part of any research project, and this is certainly true for a long-term study with many different components. Plant Science department technician, Keith Bamford, led the management of the rotation from its inception until he retired in 2019. Keith dealt with floods, droughts, poor equipment; he carried out these duties gracefully and with a high degree of skill. Thanks Keith! The rotation is now managed by Wilson Fink, UM Plant Science technician, working in collaboration with Sarah Wilcott, UM Soil Science department.

Fifteen graduate students have completed master of science or doctorate degrees using the Glenlea study. These students studied crop yield, crops’ nutritional potential, weed population dynamics, beneficial insects (e.g., weed seed-eating carabid beetles), energy use and efficiency, and soil parameters (e.g., carbon, bulk density, aggregate stability, nitrate leaching, soil enzyme activity), and greenhouse gas emissions.

Seeding in the playground, spring 2019. Left to right: Keith Bamford, field manager of Glenlea long-term rotation (1992-2019); Sarah Wilcott, UM long-term rotation technician, 2019 to present; Michelle Carkner, PhD student.

Sarah Wilcott, blade rolling barley-hairy vetch green manure, July, 2020.

What about yield?

The first question that visitors' typically ask is "What about organic yields?" The answer is in three parts. Part one: the organic grain only rotation has great wheat yields, usually similar between organic and conventional. But the next grain crop, flax, often suffers from weeds, and the oat crop that follows flax does not have enough N for a good yield. Flax and oat yields are often less than half of the conventional yields. We are addressing the challenges of weeds and low N in several ways. One example is that the green manure phase is now planted to hairy vetch. This legume adds more N to the organic system, resulting in better flax and oat yields, plus it allows us to skip one year's fall tillage.

Hairy vetch green manure provides more N and winter soil cover. Image captured November, 2020.

Part two: Yield potential in the forage-grain rotation is much higher than the grain only rotation, mostly because of N fixed by the alfalfa legume crop. However, in order to achieve these high yields, the P removed by the alfalfa hay crop must be replaced. We have used composted beef or dairy manure. Where manure has been added, alfalfa yields average 11% higher in organic than conventional. For wheat, which follows alfalfa in the rotation, yields are highest in the conventional system, lowest in the organic (no nutrients added) system, and intermediate in the organic system with manure.

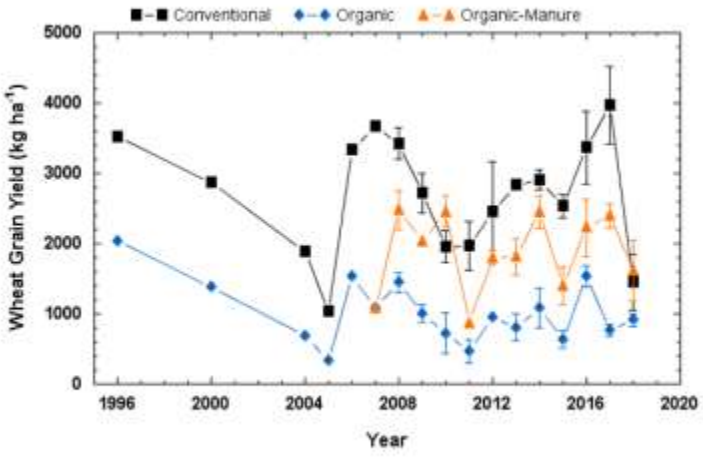

Figure 2. Wheat yields from the Glenlea long-term forage-grain rotation from 1996-2018.

Part three: The organic yields are increasing at a faster rate than the conventional yields. This is because we are figuring the organic system out, and addressing the nutrient and weed management issues in new ways. For example, beginning in 2021, we will use two new weed control tools, a camera-guided inter-row cultivation system (all crops) and a combcut (cereal crops). We are also considering adding more late-season legume cover crops and changing the flax monoculture crop to an intercrop that includes flax and another partner crop.

Soil Health

Long-term organic studies, like the Swiss DOK trial (started in 1987), have shown that organic farming can change soil physical, biological and chemical properties. Highlights of soil changes at Glenlea include: less plant available P, yet more microbial P in the organic system; higher levels of C and P mineralizing enzymes in the organic system; more mycorrhizal colonization of plant roots in the organic system; higher zinc concentrations in the organic wheat (likely linked to more mycorrhizae); and a more acidic soil pH in the conventional system. Lower pH was surprising. We know that nitrogen fertilizer reduces soil pH, but we were surprised when this decrease started showing up in year 13 at Glenlea. The more neutral pH which is still observed in the organic plots, provides advantages to soil health, especially soil bacteria.

Measuring soil microbial biomass carbon (MBC), Plant Science graduate student Sarah Braman found that the organic plots in the forage-grain rotation (both with and without manure) had levels similar to the grassland plots – all other systems had MBC levels lower than the grassland plots. MBC is a "gold standard" of soil C, so it was exciting to see the organic plots perform so well.

Plant Science graduate student April Stainsby measured aggregate stability and found evidence for more larger aggregates in the organic forage-grain rotation compared with the conventional systems in either rotation. Visitors have often remarked that the organic system in the forage-grain rotation has a spongy soil surface. These are the larger soil aggregates talking.

Looking back and looking ahead

The Glenlea archive includes samples of soil and crops from each year of production. This allows researchers to look back at changes over the past 30 years. Looking forward – well, this is summed up by Canadian soil scientist, Dr. Henry Janzen "Perhaps the best justification for the establishment and maintenance of long-term sites is that they provide a resource for future scientists posing questions we have not yet anticipated". The Glenlea study will continue to generate a critical knowledge bank that will help make organic farming more productive and sustainable.