Organic Agriculture Field Walks

July 16-17, 2019

Welcome and thank you for participating. The University of Manitoba's organic agriculture program started in 1992, and as you will see - we are still going strong. We call ourselves the "Natural Systems Agriculture" research group since our goal is to incorporate as many of nature's processes into agricultural production as possible. We are learning that the possibilities are almost endless – and this gives us hope for the future!

We are particularly grateful to the people who make the work possible and to the funding agencies supporting our work.

University of Manitoba

Carman – The Ian N. Morrison Research Farm

The Carman location is the workhorse of our organic agronomy research program. We also work on non-organic systems such as “reduced pesticide pulse production” and “next generation no-till systems”.

Glenlea Research Station

Located 20 km south of the main campus, Glenlea is an ideal site for long-term research, student training and public engagement.

Libau Research Site

Turns out that Martin`s 40 acre farmette has very low soil P, making it an ideal location for phosphorous research.

Yellow Pea Intercropping Trial

Barley, Oat, Mustard

In partnership with: Roquette Pea Processing

Spring soil test:

N – 52 lbs/ac
P – 10 ppm
K – 205 ppm

Intercropping peas with other crops has emerged as a unique way to mitigate risk on-farm and provide greater weed control, reduce disease incidence, increase seed size, provide over-yielding, and avoid lodging.

Intercropping seeding rates for organic production systems are not well established. Many intercropping studies reduce the rate of each principle and companion crops by half or thirds such that the total plant density equals to 100%. Meanwhile, work done at in Redvers, SK suggests that *doubling* the pea seeding rate in a mustard intercrop (totalling 250% total plant density) was beneficial for pea yield over and above the pea monocrop treatment. In this experiment, we kept 100% seeding rate of peas for all treatments due to the economic constraints of doubling an organic pea seeding rate.

Treatments are as follows:

Barley Intercrop (a full seeding rate will be 300 plants/m^2):
Pea monocrop (100% seeding rate; 120 plants/m^2),
100% seeding rate pea : 15% seeding rate barley,
100% seeding rate pea : 25% seeding rate barley, and
100% seeding rate pea : 50% seeding rate barley

Oat Intercrop (a full seeding rate will be 320 plants/m^2):
Pea monocrop (100% seeding rate; 120 plants/m^2),
100% seeding rate pea : 15% seeding rate oat,
100% seeding rate pea : 25% seeding rate oat, and
100% seeding rate pea : 50% seeding rate oat

Mustard (yellow) (full seeding rate will be 110 plants/m^2):
Pea monocrop (100% seeding rate; 120 plants/m^2),
100% seeding rate pea : 25% seeding rate mustard,
100% seeding rate pea : 50% seeding rate mustard, and
100% seeding rate pea : 75% seeding rate mustard

Measurements taken: plant population, weed density, biomass, pea disease ratings, lodging, biomass, yield, % dockage, and thousand kernel weight.

Mechanical weed control in dry edible beans

Katherine Stanley, Keith Bamford, Wilson Fink, Martin Entz. Funded by MPSG; CAP

The objectives are to evaluate (1) the camera guided inter-row cultivator and rotative weeder, and integrate these mechanical weed control tools into conventional, reduced herbicide and organic production.

Methods: Pinto beans were planted at recommended seeding rate and fertilized based on soil test recommendations. Weed and crop density were determined prior to treatment application.
Treatment list

a. Full herbicide (pre-plant incorporated, and 2 in crop applications)
b. Inter-row cultivation
c. Einbock Aerostar Rotation
d. Pre-plant incorporated
e. Inter-row cultivation + Rotation
f. Pre-emergent +inter-row cultivation
g. Pre-emergent + rotation
h. Pre-emergent + inter-row cultivation + rotation
i. Weedy untreated control

Measurements: Crop and Weed biomass. Yield

Preliminary Results: In 2018, this experiment was conducted in narrow rows in black beans, pinto beans and navy beans. We found that a pre-plant incorporated (PPI) herbicide resulted in the highest bean yield and mechanical weed control did not add to yield. When no PPI herbicide was used, some mechanical weeding treatments increased bean yield over the untreated (weedy) control treatment. Interestingly, regardless of higher weed biomass in treatments with no herbicide application, there was no significant difference in yield between any of the pinto bean treatments. This suggests that pinto beans have a greater tolerance to weed pressure than navy or black beans. 2018 results indicate that in all three bean types, one application of a spring PPI herbicide was sufficient to control weeds and maintain yield potential. This year, the work is being conducted on both narrow and wide row beans.

Forage resources and farm management for pasture-based livestock production

Myra Van Die, Martin Entz

Funders: Graduate scholarship to MVD, Organic Science Cluster

The objective of the field experiment is to determine whether annual crops can supplement perennial pastures during the mid-summer and early autumn in grass-fed organic livestock systems.

Treatments consist of plant species selected to provide forages for grazing during either the mid-summer or the early autumn grazing periods. Treatments were grazed by sheep to determine forage utilization and to study plant response to grazing and forage quality analysis was completed.

Mid-Summer Treatments	Early Autumn Treatments
Oat	Italian Ryegrass
Corn	Italian Ryegrass + Red Clover
Millet	Italian Ryegrass + Red Clover + Chicory
Sorghum-Sudangrass	Winter Triticale
Winter Triticale	Winter Triticale + Red Clover
Annual Ryegrass	Winter Triticale + Red Clover + Chicory

Prior to grazing, crop biomass samples were collected. Samples were separated into the crop and weed components, dried, weighed, and submitted separately for forage quality analysis. Sheep grazed each treatment for 24 hours after which another biomass sample was collected.

Preliminary observations suggest that there is potential to improve farm productivity through strategic use of annual forages. However, not all annual systems will produce feed of sufficient quality for grass-finishing in all years.

Seed increases for farmer participatory plant breeding

Michelle Carkner; Martin Entz.
Funders; USC Canada; Organic Science cluster of AAFC

The participatory plant breeding program facilitates a unique partnership between breeders and farmers. Breeders make the crosses, and we distribute the early generation offspring to organic farmers across Canada. The farmers select spikes and grow the selected seeds the following year. After three years of selection, we test them in our organic trials against registered checks. Currently, we are actively working in wheat and oat and have partnered with 76 farmers over 8 years from Vancouver Island to Prince Edward Island.

The large-plot wheat we are growing in Carman are seed increases for farmers who wish to grow their own – or another farmers' population – on their own farm. Hopefully this harvest will be enough for them to seed it with their own seeding equipment.

The farmer selected seed increases at Carman are from farmer-breeders located in Quebec, Manitoba, Saskatchewan and British Columbia.

Ecobuffers to enhance biodiversity in organic farming

Calvin Dick, Joanne Thiessen Martens, Keith Bamford, Martin Entz
Tree providers: Agriculture and AgriFood Canada, Indian Head

Ecobuffers are ecological shelterbelts; shelterbelts consisting of native trees and shrubs including N fixers. The Carman ecobuffer was planted 6 years ago. We are learning how such a vegetation strip might affect the ecology of neighboring organic grain production.

The grain production system at Carman is a 6 year rotation which includes: pea/oat green manure-wheat-soybean-hairy vetch green manure-flax-rye. One block of this rotation has an ecobuffer embedded while the second block has no ecobuffer.

Grain intercropping and cover cropping in no-till farming

Katherine Stanley, Keith Bamford, Wilson Fink, Martin Entz. Funded by Western Grains Research Foundation; Agronomy Science cluster of AAFC

Grain intercropping is a way to increase overall grain yield per unit of land, reduce disease pressure, and reduce crop fertilizer requirements.

Cover crops provide services that are not directly linked to increased yield in that year. Because soil organic matter is formed mostly by living root systems of plants, cover crops are a particularly important strategy for improving soil health.

The "Next generation no-till study" was established in 2019; the Carman site in one of 7 locations in the Prairie Provinces.

Grain intercropping treatments include:
- Canola/pea intercrop
- Soybean/corn intercrop

Cover crop treatments include:
- Fababean/barley/crimson clover

Perennial grain is also included in the rotation study. This treatment is a selection of "Kernza" made by Dr. Doug Cattani.

Glenlea Research Station

Glenlea is home to Canada's oldest organic crop rotation study, where organic systems have been compared to conventional systems for 28 years. Dr. Henry Janzen refers to long-term field studies as "listening places". Glenlea has proven its worth as such a place. Special thanks to Keith Bamford and Sarah Wilcott.

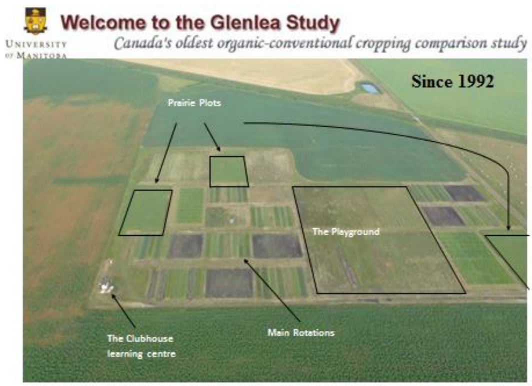
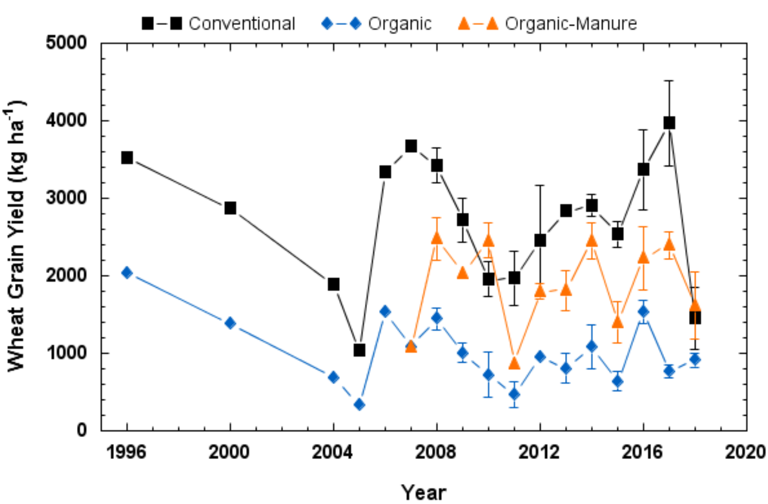
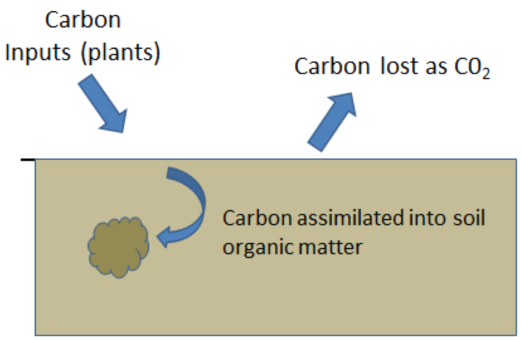


Photo credit: Gary Martens



This figure shows wheat yields in conventional, organic and organic with manure treatments (alfalfa-alfalfa-wheat-flax rotation).

Soil organic matter research at Glenlea



The amount of organic matter in soils is a function of the balance between how much plant C is lost as CO_2 and how much is assimilated into soil organic matter. Organic matter within the soil microbial pool is now regarded as the more important soil organic matter pool (Kallenbach et al. 2016). What we have learned at Glenlea is that some of our organic systems are better at assimilating soil organic matter than our conventional systems (Braman et al. 2016). We attribute this improved performance to a broader range of soil microbes in the organic system. Our work lines up with other research showing that organically managed soils can indeed be more ``energy efficient`` than conventionally managed soils – and the reason appears related to a more diverse and balanced soil nutritional program.

Kallenbach, C.M., Frey, S.D. and Grandy, A.S., 2016. Direct evidence for microbial-derived soil organic matter formation and its ecophysiological controls. *Nature communications*, *7*, p.13630.

Braman, S., Tenuta, M. and Entz, M.H., 2016. Selected soil biological parameters measured in the 19th year of a long term organic-conventional comparison study in Canada. *Agriculture, Ecosystems & Environment*, *233*, pp.343-351.

Organic Oat Breeding

In partnership with: Agriculture and Agri-Food Canada Breeder: Dr. Jennifer Mitchell-Fetch. Funders: Grain Millers, Organic Science cluster of AAFC.

Currently, the vast majority of varieties available to organic farmers were bred under conventional conditions. Major differences in growing environment and production practices between conventional and organic farms require suitable varieties for optimal performance. Research has shown that when breeding varieties, the selection environment in which the lines are selected and grown is critical. Two organically bred oat varieties – AAC Oravena and AAC Kongsore, have come out of this program.

This year, Mitchell-Fetch's organic oat program contains 16 lines that were bred by organic farmers across the Prairies and Quebec. These lines passed her initial yield and quality screening in 2018. In fact – she could only keep 2 of her lines from 2018 to test this year.

Checks used: CDC Dancer, AC Morgan, Summit, AAC Oravena, AAC Kongsore, CS Camden

Measurements: Emergence, days to heading, disease, lodging, maturity, height, yield, thousand kernel weight, test weight, plumps vs. thins.

Food Grade Organic Soybean Breeding

Istvan Rajcan, Univerity of Guelph; Martin Entz and Michelle Carkner, University of Manitoba

Funders: Grain Growers of Ontario; Organic Science cluster of AAFC

The main goal of the research is to build knowledge on how to efficiently develop, through plant breeding, new soybean cultivars for Organic growers to maximize their competitiveness, efficiency and volume of production such as yield. This will be achieved by growing breeding populations of soybean that have been developed from bi-parental food grade crosses and selected in previous years on contrasting Organic and non-Organic farms to develop superior new cultivars that can be grown by organic soybean farmers. The latter will reduce the cost of production and improve competitiveness and profitability of the organic soybean sector in Canada.

2019 represents the first field season in Manitoba with experiments at Glenlea and Carman, Manitoba.

This research builds on previous research on organic soybean cultivar performance by Michelle Carkner.

Carkner, M.K. and Entz, M.H., 2017. Growing environment contributes more to soybean yield than cultivar under organic management. *Field crops research*, *207*, pp.42-51.

Urban to rural cycled amendments for phosphorus supply in organically managed systems

MSc Student: Jessica Nicksy Co-advisors: Martin Entz and Brian Amiro. Funders: Graduate scholarship to JN and Organic Science cluster of AAFC.

This research project evaluates products that contribute to cycling nutrients from urban to rural landscapes, with a focus on their ability to supply phosphorus in depleted organic soils. The wheat trial we'll be looking at features 6 amendment treatments, the first 3 of which contribute to urban to rural nutrient cycling:

1. Struvite, a phosphate mineral that can be extracted from municipal wastewater
2. Black soldier fly larvae frass, the waste product of larvae used to process urban food waste
3. Anaerobic digestate, from the decomposition of municipal green waste and food processing waste
4. Aerobic compost with horse manure and bedding as the primary feedstock, representing a typical amendment that might be used on an organic farm
5. Mono-ammonium phosphate (MAP) synthetic fertilizer, commonly used in conventional agriculture
6. Unfertilized control

The trial uses two wheat varieties: AAC Brandon, the most popular variety in Manitoba; and BJ08-IG, a farmer-selected line chosen under organic, low-P conditions. We'll be collecting 3 biomass samples, measuring final yield, measuring nitrogen and phosphorus uptake on our final biomass and yield samples, and measuring soil phosphorus in each plot. Our initial biomass results show the highest biomass in the MAP, frass and compost treatments, with BJ08-IG, the farmer selected line, responding more strongly to the frass and compost, while Brandon responded more strongly to the synthetic fertilizer.

Participatory Plant Breeding: Oats

In partnership with: Dr. Jennifer Mitchell-Fetch, AAFC and USC-Canada

After 3 years of selection, we 'test drive' the farmer selected wheat and oat lines against each other and check varieties. In some cases, the same population was sent to multiple farmers, allowing us to observe how farmers in different regions of the Prairies shaped a population from the same cross.

Checks used: AC Morgan, CDC Dancer, AAC Kongsore, Summit

Farmer selected lines tested at Libau include:

Plot	TRT Name	Location Selected	Notes:
23	11P01-15-AS	Wood Mountain, SK	Tested in AAFC's organic oat trials
22	11P20-15-TM	Neaubergthal, MB	Tested in AAFC's organic oat trials
14	11P15-16-MW	Beausejour, MB	Selected close to Libau
9	11P13-15-ML	Vonda, SK	High Yielding at both sites in 2017*
8	11P06-15-KS	Grandview, MB	High Yielding at Carman in 2017*, being tested in AAFC's organic oat trials
6	11P22-16-JM	Fort Vermilion, AB	High yielding at Somerset in 2017*
*Lines were tested in 2017 in Carman and Somerset. Carman was a high yielding site and Somerset was a low-yielding site (due to moisture deficit and salinity)			

Measurements: Emergence, early season vigour, days to heading, height, yield, thousand kernel weight, test weight

Alternative P sources for green manure and vegetable production
Martin Entz and Joanne Thiessen Martens. Funders: Ostara and the Organic Science Cluster of AAFC.

One surprise is our research is the observation that legume green manure systems are sometimes seriously hampered by lack of soil P. When this happens, the `soil building` green manure crop has difficulty growing resulting in poor atmospheric nitrogen fixation.

At Libau, soils have between 2 and 5 ppm Olson Phosphorous – very low. Our hypothesis is that adding P sources to green manures will increase legume growth and increase biological N fixation.

The P sources tested include:

1. Composted beef cattle manure
2. Struvite
3. Humanure (manure from a composting toilet)

Green manures include:

1. Pea oat mixture
2. Hairy vetch
3. Alfalfa

Year 1 of the study involves the green manures. Year 2 involves vegetable production.

1. Onions
2. Potatoes
3. Sweet corn

Funders and supporters

We are truly grateful for the financial and other support from the following institutions, organizations and companies.

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Manitoba Pulse and Soybean Growers Association
Manitoba Wheat and Barley Growers Association
Mountain Equipment Cooperative
Ostara Nutrient Recovery Technologies
Overton Environmental
Roquette Pea Processing
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USC Canada
Western Grains Research Foundation

A special thanks to all the farmers involved in the participatory plant breeding project, the green manure survey project (not discussed here) and the grass-fed livestock project.