Parkland Crop Diversification Foundation

2019 ANNUAL REPORT

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Introduction

The Parkland Crop Diversification Foundation (PCDF) is involved in a number of value-added and diverse projects that are summarized in this annual report. PCDF is located in the Parkland region of Manitoba and has a close liaison with Manitoba Agriculture, Food and Rural Development (MAFRD).

PCDF works alongside three other Diversification Centres in the province, including CMCDC in Carberry, PESAI in Arborg and WADO in Melita.

The Parkland Crop Diversification Foundation owes its success to the excellent cooperation and participation received from the PCDF board of directors, producers, industry and cooperating research institutions.

The 2019 season was full of hard work and dedication from the staff to execute all the research activities that came with an impressive project list. A thank you goes out to the staff of James Frey, Jessica Frey, Brooklyn Bartel, Emily Shiner and Mackenzie Kozak.

Funding is essential for the Parkland Crop Diversification Foundation's everyday activities to occur. This year PCDF received core funding from the Canadian Agricultural Partnership (CAP) and Agriculture Sustainability Initiative (ASI) programs, as well as from trial cooperators, producers, and members of the local community. PCDF is always open to project ideas and learning about the production concerns of local producers, so please feel free to contact us with any project proposals. For project submissions or additional information, please refer to the Contact info supplied on this website.

Parkland Crop Diversification Foundation (PCDF)
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Website: www.diversificationcentres.ca

2019 Industry Partners

Agricultural and Agri-Food Canada
Canadian Hemp Trade Alliance
Crop Development Centre
Hemp Genetics International
Linseed Coop
Manitoba Agriculture
Manitoba Crop Variety Evaluation Team
Manitoba Diversification Centres
Montra Crop Science
Northern Quinoa
Parkland Coop
Parkland Industrial Hemp Growers
PepsiCo/Quaker Oats
Phillex Quinoa
Tamarack Farms
University of Alberta
University of Manitoba
University of Saskatchewan

2019 PCDF Board of Directors

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2019 Meteorological Data

Table 1: Roblin 2019 Season Report by Month (based on 30-year average)

Month	Precipitation		Crop Heat Units		Growing Degree Days	
	Actual (mm)	% Normal	Actual	% Normal	Actual	% Normal
April	15	63	83	251	38	486
May	7	17	254	79	128	75
June	59	81	511	97	306	98
July	83	117	632	98	385	98
Aug	44	81	510	89	302	88
Sept	58	110	323	111	201	123
Oct	11	43	40	94	13	124
Total	277	80	2372	97	1385	98

Information gathered from Manitoba Agriculture Growing Season Report website:
https://web43.gov.mb.ca/climate/SeasonalReport.aspx

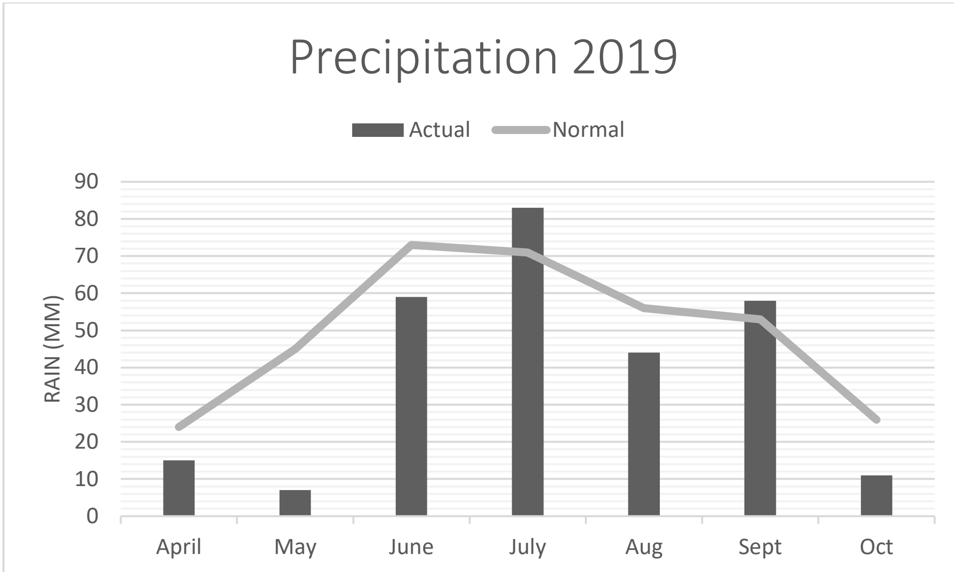


Figure 1: Roblin 2019 Precipitation April 1 – October 31

2019 Extension Activities

Name	Medium	Date	Location
Ag Days	Booth	January	Brandon
CropConnect	Booth	February	Winnipeg
Peas Workshop	Workshop	March	Roblin
Ag in the Classroom	School group tours	June	Brandon
Crops-A-Palooza	Featured speaker	July	Carberry
Field Day	Research site tour	July	Roblin
Field Event – Annual Crops for Full Season Cover and Livestock Grazing	Featured speaker	August	Crystal City
CHTA Annual Convention	Panel Presenter	November	Calgary
Dakota Innovation, Research and Technology (DIRT) Workshop	Featured speaker	December	NDSU Fargo

PCDF participated in Ag Days, CropConnect and Crops-A-Palooza with the other Diversification Centres.

2019 PCDF Field trials

Plot information		**Equipment**
At seeding:	7m x 1.2m	5-Row Fabro Disc Seeder
Trimmed:	5m x 1.2m	Plot Sprayer
Plot Area:	$6m^2$	Wintersteiger Plot Combine
Alleyways:	2m	

Manitoba Crop Variety Evaluation (MCVET) Trials

Manitoba Crop Variety Evaluation Trials (MCVET) facilitates variety evaluations of many different crop types in this province. The purpose of MCVET trials is to grow both familiar (checks or reference) and new varieties side by side in a replicated manner in order to compare and contrast various variety characteristics such as yield, maturity, protein content, disease tolerance, and many others.

During 2019, PCDF did variety evaluations for winter wheat, fall rye, oats, barley, fababeans, peas and flax. The pea trial was discontinued due to poor plot establishment and high weed pressure from volunteer flax that emerged after flowering (removing herbicide options).

From each MCVET site across the province, yearly data is collected, combined, and summarized in the 'Seed Manitoba 2019' guide. Hard copies are available at most Manitoba Agriculture and Ag Industry Offices.

Table 1: 2019 MCVET Trials

Crop type	# of plots	Site
Barley	18	Roblin
Oats	24	Roblin
Flax	33	Roblin
Fababean	90	Roblin
Fall Rye	15	Roblin
Winter Wheat	24	Roblin
Total plots	204	

For MCVET trial results conducted by PCDF, please see *Seed Manitoba Guide* or visit websites *www.seedinteractive.ca* or *www.seedmb.ca*.

Table 2: Summary of 2019 PCDF Trials

Crop Type	Collaborators	Purpose	Number of Plots
Barley	University of Manitoba	Assessment of the current Fusarium Head Blight Risk Model	12
Barley	PCDF	Cover Crop Grazing	3
Canola	PCDF	Cover Crop Grazing	3
Corn	Agricultural and Agri-Food Canada	Variety Trial	90
Corn	Agricultural and Agri-Food Canada	Corn Nursery	500
Durum	University of Manitoba	Assessment of the current Fusarium Head Blight Risk Model	3
Flax	Linseed Coop	Variety Trial	78
Flax	Manitoba Agriculture	Evaluation of European Lines for North American climates	21
Fruit Demonstration	University of Saskatchewan	Sour Cherry and Haskap	10
Hemp	Montra Crop Science	Application of organic acids to improve soil health	12
Hemp	Canadian Hemp Trade Alliance	National Industrial Hemp Variety Evaluation Trials	56
Hops	Manitoba Diversification Centres	Establishment year of hopyard demonstration	24
Oats	Agricultural and Agri-Food Canada	Evaluation of new oat lines being developed for organic production	75
Oat-hairy vetch	PCDF	Intercropping trial with different seeding rates	44
Pea Intercrop	Manitoba Diversification Centres	Evaluating potential for intercropping peas	44
Pea Quinoa Intercrop	Tamarack Farms	Treatments of High and Low Pea and Quinoa seeding rates combined	33
Quinoa	Phillex Ltd	Variety Trial	21
Quinoa Cover Crop Relay	Tamarack Farms	Quinoa seeded together alternately with 6 varieties of clover, 3 varieties of grass and 1 vetch	44
Six-Year Crop Rotation	PCDF	Wheat nitrogen ramp - Year 2 of six-year rotation	28

Soybean	Agriculture and Agri-Food Canada	Assessment of soy protein by variety	48
Spring Wheat	University of Manitoba	Assessment of the current Fusarium Head Blight Risk Model	3
Silage Intercrop	PCDF	Evaluation of intercrop mixes for silage production	21
Spring Wheat	Parkland Coop	Variety Trial	30
Spring Wheat	PCDF	Cover Crop	1
Spring Wheat	PCDF	Cover Crop Grazing	3
Spring Wheat	PCDF	6 Year Rotation Year 2 – Wheat Nitrogen Ramp	28
Winter Wheat	Ducks Unlimited	Evaluation of "producer practice" fertility and balanced "high yield practice" fertility	18
Winter Wheat	University of Manitoba	Assessment of the current Fusarium Head Blight Risk Model	3

Table 3: 2019 PCDF Exclusive Trials

Crop Type	Collaborators	Number of Plots
Oats	Crop Development Centre	108
Oats	Pepsi Quaker Oats	424
Quinoa	Northern Quinoa Production Corp	99

Table 4: Field-Scale Collaboration

Joe Gardner	Grain and Forage Oat Hairy Vetch Intercrop	Crystal City

Table 5: 2019 PCDF Discontinued Trials

Crop Type	Collaborators	Purpose	Number of Plots
Peas	MCVET	Variety Trial	78
Intermediate Wheatgrass	PCDF	Demonstration	32

University of Manitoba FHB Risk Model – Barley, Durum, Spring Wheat, Winter Wheat

Project duration: September 2018 – August 2019
Objectives: To increase understanding of resulting Fusarium Head Blight (FHB) infection for spring and winter wheat, barley and durum based on the current model.
Collaborators: Manasah Mkhabela PhD., Research Associate University of Manitoba Soil Science

Background
Farmers need improved decision-making tools in order to assess the local risk of Fusarium Head Blight (FHB). Better tools would improve judgement on whether or not to use fungicide and how to time application. The project recognizes that the current model for predicting the presence of FHB is insufficient and is gathering data across the province for different treatment plans using both known fusarium resistant and fusarium susceptible varieties.

This project design centred on learning more about how spore density in the air at specific times of plant maturation affected FHB infection. The specific window of interest is during flowering and up to five days before flowering.

Entries: 3 varieties for each winter wheat, spring wheat and barley; 1 variety for durum
Seeding: Winter Wheat seeded Sept 20 2018;
Barley, Spring Wheat and Durum seeded May 17
Harvest: Sept 6, 2019
Varieties: Winter Wheat: Moats, AAC Gateway and Emerson
Spring Wheat: AAC Elie; AAC Brandon and Muchmore
Barley: CDC Copeland; AAC Connect; and AAC Synergy
Durum: Strongfield

Data collected	**Date collected**
Plant Counts:	Three leaf stage (and spring emergence for winter wheat)
Plant Staging:	Weekly staging beginning at late booting through late flowering
Spore Collection:	Beginning just before winter wheat flowering spanning five weeks and covering all cereals flowering
FHB sampling & rating:	18-21 days after flowering – Enumeration of FHB afflicted kernels per head in a given sample size of fifty heads per plot
Heights:	Aug 5
Yield:	Sept 6
Moisture:	Sept 6

Grain samples sent away to analyze for grading, fusarium species assessment, and mycotoxin analysis
Agronomic info
Previous year's crop: Cereals cover crop
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east

Seedbed preparation: Tilled once and then harrowed

Table 2: Spring 2019 Soil Test

	Available	Needed for Barley	Needed for Wheat	Needed for Durum
N	4.5 lb/ac	100 lb/ac	185 lb/ac	185 lb/ac
P	54.6 lb/ac	10 lb/ac	10 lb/ac	10 lb/ac
K	57.3 lb/ac	-	57.3 lb/ac	-
S	9.7 lb/ac	-	-	-

Table 3: Winter Wheat Added Fertilizer

Blend	Blend (lbs/ac)	Actual lbs N	Actual lbs P	Actual lbs K
46-0-0	397.6	186.9	-	-
11-52-0-0	19.2	2.11	10	-
0-0-60	95.5	-	-	57.3
Total	-	189	10	57.3

N and K side banded; P banded with seed

Table 4: Spring Wheat and Durum Added Fertilizer

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	397.6	186.9	-
11-52-0-0	19.2	2.11	10
Total		189.0	10

N side banded; P banded with seed

Table 5: Barley Added Fertilizer

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	212.8	97.89	-
11-52-0-0	19.2	2.11	10
Total	-	100.0	10

N side banded; P banded with seed

Table 6: Herbicide Application

Crop stage	Date	Product	Rate
Pre-emerge	Sept 14	RoundUp	0.67 L/ac
	May 14	Heat	28.4 g/ac
		Glyphosate	0.64 L/ac

In-crop	June 12	Prestige	0.8 L/ac
		Curtail M	0.5 L/ac
		Puma	0.413 L/ac

Results

Grain samples were sent for Fusarium specific analysis, but no report for these results has yet been generated. PCDF will post a link when this report is available. Average yields for the crops tested are shown in Table 1. The quality ratings for the crops are not included here.

Table 1: Average yields for cereals tested

Crop	Yield (bu/ac)
Winter wheat	76
Spring wheat	72
Barley	94
Durum	61

Organic Oats Variety Evaluation

Project duration: May 2019 – October 2019
Objective: To evaluate oat varieties for organic production.
Collaborators: Jennifer Mitchell-Fetch, AAFC Brandon

Background
Research suggests that selection of cereal crops specific to organic agriculture should be conducted on organically managed land [1,2]. Conventional management systems may mask or confound certain plant characteristics, resulting in selection of sub-optimal cultivars for organic production systems. Organic management conditions were used for the trial at PCDF, although the site was not certified organic.

Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 25 varieties
Seeding: May 13
Harvest: Sept 14

Table 1: Varieties included at Roblin 2019

10P02-14-CH	11P15-15-MW	11P01-15-AS	11P10-16-KS	09P02-15-TM
11P06-15-KS	11P05-15-ML	AC Morgan	11P22-16-JM	OT8007
13P12A-AE	11P21-16-AS	11P22-16-FB	CS Camden	AAC Oravena
11P17-16-JM	CDC Dancer	11P20-15-TM	13P13-AQ	11P07-16-KS
Summit	09N021-13-MW	08P12-14-JD	11P19-16-FB	AAC Kongsore

Data collected **Date collected**
Maturity: Aug 19-26
Height: Aug 11-15
Yield: Sept 17
Moisture: Sept 17

Agronomic info
Previous year's crop: Summer fallow
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Heavy harrowed twice

Table 2: Spring 2019 Soil Test

	Available
N	143 lb/ac
P	21 ppm
K	274 ppm

Results

Ongoing testing for oat performance under organic growing conditions has resulted in the development of two new varieties especially suited for organic cultivation, namely AAC Oravena and AAC Kongsore. AAC Oravena is the first oat cultivar developed under organic management. Both varieties have good yield and lodging resistance, and are licensed to Grain Millers Canada Corp.

References

[1] Reid, T., Yang, R.-C., Salmon, D. and Spaner, D. (2009). Should spring wheat breeding for organically managed systems be conducted on organically managed land? Euphytica 169:239-252.

[2] Dalhousie University, Organic Agriculture Centre of Canada. The crafting of organic oats. https://www.dal.ca/faculty/agriculture/oacc/en-home/about/about-oacc/documents/newpaper-articles/newsarticles-2012/newsarticles-2012-fetch.html

Parkland Coop Wheat Variety Evaluation

Project duration: May 2019 – August 2019
Objectives: To evaluate wheat varieties for the Parkland Coop
Collaborators: Dean Spanner – Coordinator, University of Alberta Research Station
Klaus Strenzke – Research Technician, University of Alberta Research Station

Background
In 2019, the Parkland Cooperative wheat trial was conducted locations across western Canada as a resource for wheat breeders to generate data in support of registration of new Canada Western Red Spring varieties. Additional samples were taken to test for wheat midge at the end of July.

Materials & Methods
Experimental Design: Rectangular Lattice
Entries: 30 varieties
Seeding: May 14
Harvest: Sept 19

Table 1: Varieties included in trial at Roblin, 2019

AC Splendor	PT5002	PT5005	PT498	PT661
Carberry	PT789	PT658	PT5006	PT794
Glenn	PT256	PT793	PT5007	PT795
Parata	PT493	PT257	PT5008	PT796
PT491	PT495	PT496	PT659	PT797
PT492	PT5003	PT497	PT660	PT798

Agronomic information
Previous year's crop: Oats
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Heavy harrowed twice

Data collected	**Date collected**
Maturity:	Aug 19 – Sept 1
Height:	July 17
Lodging:	Sept 19
Yield:	Sept 19
Moisture:	Sept 19

Table 2: Spring 2019 Soil Test

	Available	Needed

N	71 lb/ac	118 lb/ac
P	33 ppm	15 lb/ac
K	272 ppm	-

Table 3: Added N and P

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	97.6	44.88	0
11-52-0-0	19.23	2.12	10
Total	-	47	10

N side-banded; P banded with seed

Table 4: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 19	Heat	28.4 g/ac
		Round-up	0.64 L/ac
In-crop	June 12	Prestige SC-B	0.8 L/ac
		Curtail M	0.5 L/ac
		Puma	0.413L/ac
Desiccation	Aug 17	RoundUp	0.94 L/ac

Project findings

The data were generated for the Parkland Coop. Due to intellectual property issues pertaining to Plant Breeders' Rights, results for individual lines are not provided in this report. For more information on the Coop trial, contact Klaus Strenzke, University of Alberta, strenzke[at]ualberta.ca.

Evaluating Yield Potential of New Winter Wheat Varieties

Project duration: September 2018 – August 2019
Objectives To establish a fertility program suitable for achieving high yield winter wheat on the Prairies
Collaborators: Ducks Unlimited, WesternAg

Background
Following centuries of extensive work in winter wheat production in North America, many researchers and producers have begun to implement best management practices to obtain higher grain yield. Management practices that can be utilized to improve winter wheat production are; increasing seeding rate and application of starter fertilizer by banding during seeding (Anderson, 2008). Fertility management, in particular nitrogen and phosphorus, remains the integral part of the overall management package aimed at achieving higher yields (Halvorson et al. 1987). The ideal fertility management package would help counteract escalating cost of production per unit area, which is the main goal that producers aim to achieve. There is still a knowledge gap on the rates as well as timing of application of nitrogen fertilizer, particularly in Western Canada, that would result in improved yield per given area without compromising on the quality of grain. Morris et al. (2018) suggested the use of adaptive use of nitrogen to help augment and improve nitrogen application rate decision making by farmers. Therefore, there is a great need to continue with research on the best way that can be availed to producers so as to maximise production.

Materials and Methods
The field trial was established at four locations; Melita, Arborg, Carberry and Roblin in Manitoba in 2018/2019 growing season. The information presented below is for the Roblin site.

Materials & Methods

Experimental Design:	RCBD in a 2x3 factorial (fertility practice x wheat varieties)
Entries:	30 varieties
Seeding:	September 12, 2018
Harvest:	September 12, 2019

Table 1: Varieties included in trial at Roblin, 2019

Wildfire	Gateway	Elevate

Agronomic information

Previous year's crop:	Oats
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed twice

Data collected and date collected

Maturity:	August 13
Height:	August 13
Yield:	September 12
Moisture:	September 12

Table 1: Spring 2019 Soil Test

	Available	*Needed*
N	4.5 lb/ac	185 lb/ac
P	54.6 lb/ac	20 lb/ac
K	57.3 lb/ac	0 lb/ac

Fertilizer treatments included Producer practice at 100 lbs of nitrogen (urea plus agrotain) per acre applied in spring and 30 lbs phosphorus banded at seeding in fall. Balanced fertility practice as per Western Ag recommendations was split applied with 50% banded at seeding and the other 50% urea plus Agrotain broadcasted in spring. A summary of fertility treatments is presented in table 2a:

Table 2a: Fertility treatments for Balanced (high yield) and Producer practices

Practice	**N**	**P**	**K**	**S**
Balanced fertility with 50 % N applied in fall	44-0-0	11-52-0	0-0-60	20-0-0-24
Producer practice with N applied in spring	46-0-0	11-52-0		

All fertilizer side-banded

Table 3: Herbicide Application

Crop stage	*Date*	*Product*	*Rate*
Pre-emerge	Sept 14	Round-up	0.67L/ac
In-crop	June 12	Prestige	0.8L/ac
	June 12	Curtail M	0.5L/ac
	June 12	Puma	0.413L/ac
	June 17	Folicur	0.5L/ac
	July 17	Prosaro	0.325L/ac

Results

Variety appeared to have influenced wheat yield and protein at 3 of the 4 sites under study in 2019. Elevate and Wildfire varieties had significantly higher yields compared to Gateway at Melita (P=0.001) and Arborg (P=0.036) while there were no significant differences among varieties at Roblin and Carberry. Although Gateway variety had lower grain yield, it had significantly higher protein content of 15.8% at Melita, 13.8% at Roblin and 13.5% at Arborg compared to Wildfire and Elevate. Wildfire had significantly higher protein content (15.2%) compared to Elevate (14.4%) at Melita while there were no significant differences between the same varieties at Arborg. There were no significant differences in protein content at Carberry. Balanced application of fertilizer resulted in significantly higher grain yield at Roblin (5031 kg ha^{-1}) and Carberry (4864 kg ha^{-1}) compared to 100% spring applied. Balanced application of fertilizer resulted in significantly higher protein content compared to 100% spring applied fertilizer at Roblin and Arborg. On the other hand, 100% spring applied fertilizer resulted in significantly higher protein than balanced fertilizer application at Carberry. There was a significant interaction between variety and fertilizer on protein content and no influence on wheat yield. An interaction of Gateway variety and balanced fertilizer application resulted in significantly higher protein content (16%) compared to other interactions. Under both fertilizer systems, Elevate resulted in the lowest protein content of 14.4 and 14.5% at Melita (Table 2b). Based on the preliminary results from this study, balanced fertilizer application seemed to a better option to improve wheat yield and protein content at least at two sites but additional site years of study would confirm proper recommendations for use by winter wheat producers.

Table 2b: Analysis of variance and mean comparison for wheat yield and protein content at Melita, Roblin, Arborg and Carberry in 2019

		Location							
		Melita		**Roblin**		**Carberry**		**Arborg**	
		Yield kg ha⁻¹	**Protein %**	**Yield kg ha⁻¹**	**Protein %**	**Yield kg ha⁻¹**	**Protein %**	**Yield kg ha⁻¹**	**Protein %**
Variety †	1	3974a	14.4c	4802	12.6b	4459	13.9	5860a	12.1b
	2	3688b	15.8a	4361	13.8a	4879	13.7	5188b	13.5a
	3	4150a	15.2b	4646	11.4c	4621	13.8	5728a	12.3b
Fert‡	1	3901	15.2	4175b	12.2b	4442b	14.3a	5466	12.4b
	2	3974	15.2	5031a	13.0a	4864a	13.4b	5718	12.9a
Var* Fert	1*1	4000	14.5d	4228	12.4	4470	14.5	5823	12.1
	2*1	3682	15.6b	3761	13.5	4662	14.1	5140	13.0
	3*1	4020	15.4bc	4536	10.6	4194	14.2	5434	12.0
	1*2	3948	14.4d	5375	12.7	4449	13.4	5898	12.1
	2*2	3694	16a	4961	14.1	5097	13.3	5235	14.0
	3*2	4280	15.2c	4757	12.3	5047	13.4	6022	12.6
P values	**Var**	**0.001**	**<0.001**	0.574	**<0.001**	0.524	0.909	**0.036**	**0.001**
	Fert	0.324	0.891	**0.029**	**0.003**	0.182	**0.035**	0.212	**0.027**
	Var*Fert	0.213	**0.049**	0.441	0.082	0.504	0.933	0.481	0.236
	CV%	4	1	16	4			7	4

†Variety 1=Elevate, Variety 2=Gateway, Variety 3=Wildfire; ‡Fert 1=100% Spring applied, Fert 2=Balanced application

References

Anderson, R. L. 2008. Growth and Yield of Winter Wheat as Affected by the Preceding Crop and Crop Management. Agronomy Journal 100 (4) 977-980.

Halvorson, A.D., Alley, M. M., and Murphy, L. S. 1987. Nutrient Requirements and Fertilizer Use: In Wheat and Wheat Improvement – Agronomy Monograph (13) 2nd Edition. Madison, WI 53711, USA.

Morris, T.F., Murrell, T. S., Beegle, D. B., Camberato, J., Ferguson, R., Ketterings, Q. 2018. Strengths and limitations of nitrogen recommendations, tests, and models for corn. Agron. J. 110:1–37. doi:10.2134/agronj2017.02.0112

Agriculture Agri-Food Canada Corn Variety Evaluation

Project duration: 2018 – 2023
Objectives: To develop and release early maturing cold tolerant corn inbreds with emphasis on the 1800-2000 CHU market.
Collaborators: Lana Reid Ph.D – AAFC Research Scientist Ottawa Research and Development Centre
Manitoba Corn Growers Association

Background

The objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance and disease resistance. The trial is being conducted at sites across five Canadian provinces. The anticipated impact of developing earlier maturing, cold tolerant corn will expand the acreage of corn production in Canada.

Project findings

These data were generated for AAFC; however, due to intellectual property issues pertaining to Plant Breeders' Rights, results for individual lines are not provided in this report. For more information on this variety trial, see here for publications by Lana Reid.

Materials & Methods

Experimental Design: Random Complete Block Design
Entries: 30 varieties
Seeding: May 17
Harvest: Oct 30

Data collected	**Date collected**
Yield:	Nov 1
Moisture:	Nov 1

Agronomic info

Previous year's crop: Green manure blend – oat, pea, Italian Ryegrass, Japanese Millet, Persian Clover, Common Vetch, Sugar Beet, Phacelia, Chicory, Turnip Rape
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Tilled and harrowed

Table 1: Spring 2019 Soil Test

	Available	Needed
N	60 lb/ac	192 lb/ac
P	18 ppm	15 lb/ac
K	204 ppm	16 lb/ac

Table 2: Added N and P

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	280.07	128.83	0
11-52-0-0	28.85	3.17	15
Total	-	132	15

N side-banded; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 23	Heat	28.4 g/ac
		Round-up	0.64 L/ac
In crop	July 27	Sortan IS	30.4 g/ac
	2nd week of August	Weed whacking between rows	-
	End of August	Tilling between rows	-

Results

This project is part of a long-term, multi-site study led by Lana Reid. Research findings will be made available by Lana Reid and team at the completion of the project in 2023. For general information related to corn research conducted by Lana Reid, see her Agriculture and Agri-Food Canada webpage.

Agriculture Agri-Food Canada Corn Nursery

Project duration: May 2019 – October 2019
Objectives: To develop and release early maturing cold tolerant corn inbreds with emphasis on the 1800-2000 CHU market.
Collaborators: Lana Reid Ph.D – AAFC Research Scientist Ottawa Research and Development Centre

Background
The objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance and disease resistance. The trial is being conducted at sites across five Canadian provinces. The anticipated impact of developing earlier maturing, cold tolerant corn will expand the acreage of corn production in Canada.

Project findings
This project is part of a long-term, multi-site study led by Lana Reid. Research findings will be made available by Lana Reid and team. For more information research by Lana Reid see here.

Materials & Methods

Experimental Design:	500-row observation nursery
Entries:	500
Seeding:	May 17
Harvest:	Oct 30

Data collected	**Date collected**
Tasseling Date:	Aug 2 – Sept 12
Silking Date:	Aug 12 – Sept 18
Ear Formation:	Aug 6 – Sept 18

Agronomic info

Previous year's crop:	Green manure blend – oat, pea, Italian Ryegrass, Japanese Millet, Persian Clover, Common Vetch, Sugar Beet, Phacelia, Chickory, Turnip Rape
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Tilled and harrowed

Table 1: Spring 2019 Soil Test

	Available	Needed
N	60 lb/ac	192 lb/ac
P	13 ppm	15 lb/ac
K	204 ppm	16 lb/ac

Table 2: Added N and P

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	280.07	128.83	0
11-52-0-0	28.85	3.17	15
Total	-	132	15

N side-banded; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 23	Heat	28.4 g/ac
		Round-up	0.64 L/ac
In crop	July 27	Sortan IS	30.4 g/ac
	2nd week of August	Weed whacking between rows	-
	End of August	Tilling between rows	-

Results

This project is part of a long-term, multi-site study led by Lana Reid. Research findings will be made available by Lana Reid and team at the completion of the project in 2023. For general information related to corn research conducted by Lana Reid, see her Agriculture and Agri-Food Canada webpage.

Agriculture Agri-Food Canada Conventional Soy Protein Variety Evaluation

Project duration: May 2019 – October 2019
Objectives: The project tests 20 varieties of conventional soybean as part of a broader project examining protein differences between eastern and western Canada sites
Collaborators: Elroy Cober – Research Scientist, soybean breeding and genetics, AAFC
Kirsten Slusarenko – Soybean breeding AAFC

Background
Roblin is one of many sites across Canada taking part in this project to determine soybean protein content differences between eastern and western Canadian growing sites.

Materials & Methods
Experimental Design: Rectangular lattice
Entries: 20 entries; 4 replications
Seeding: May 23
Harvest: Oct 21

Data collected	**Date collected**
Emergence:	Jun 3-20
Population Score:	Jun 20
Heights:	July 16
Maturity:	Sept 27
Lodging:	Oct 21
Yield:	Oct 23-24
Moisture:	Oct 23-24

Agronomic info
Previous year's crop: Barley
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Heavy harrowed twice

Table 1: Spring 2019 Soil Test

	Available	
N	71	lb/ac
P	33	ppm
K	272	ppm

Table 2: Added N and P

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	-	-	0
11-52-0-0	19.23	2.12	10
Total	-	2.12	10

Inoculant added with seed; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 23	RoundUp	0.64 L/ac
		Heat	28 g/ac
In-crop	Jul 19	Quizalafop	0.3 L/ac
		Viper	0.4 L/ac

Results

The results for the varieties grown in Roblin are presented in Figure 1.

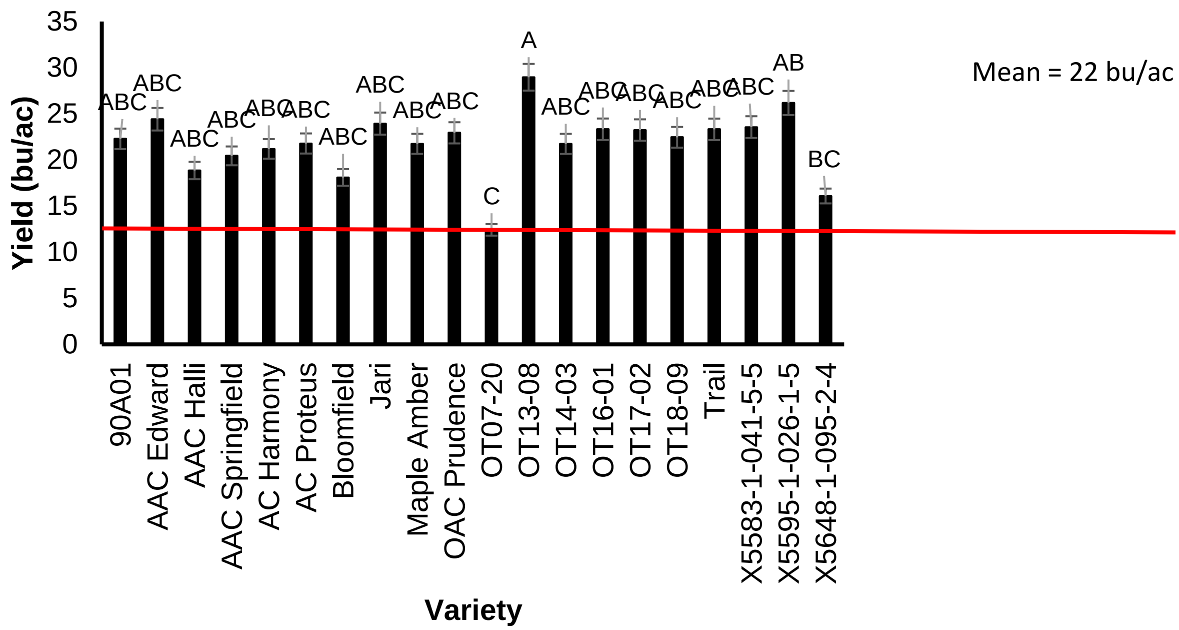


Figure 1: Yield by soybean variety in Roblin 2019.

Varieties not connected by the same letter are statistically significant from each other. After smoothing data for missing plots and irregular emergence, the coefficient of variation for the trial is 12.4%. This project is part of a long-term 5-year multi-site study across Canada, led by Elroy Cober. Complete research findings will be made available by Elroy Cober and team. For general information related to corn research conducted by Elroy Cober, see his [Agriculture and Agri-Food Canada webpage](#).

Determining agronomic suitability of European flax (linseed) cultivars in Manitoba

Project duration: 2018-2019
Objectives: To examine agronomic attributes (yield, height, maturity) of European-origin flaxseed cultivars and to see if they have a competitive advantage and agro-climatic fit within Manitoba flax production areas.
Collaborators: Manitoba Flax Growers Association (MFGA), Parkland Crop Diversification Foundation (PCDF), Prairies East Sustainable Agriculture Initiative (PESAI), Westman Agricultural Diversification Organization (WADO), Crop Development Centre (CDC), BASF (financial support) and varietal sponsors Limagrain Nederland and van de Bilt saden en vlas.

Background
Despite the declining role of flax in Manitoba, the crop has an important role for its ability to break disease cycles and provide a stable, steady return as part of a balanced rotation. Currently, only a single flax breeder remains in Canada at the Crop Development Centre (CDC) in Saskatoon, Saskatchewan. With the introduction and evaluation of European lines, a higher yielding cultivar, or a cultivar with more desirable quality characteristics may be found to be well suited to Manitoba's agro-climate.

Materials & Methods
Experimental Design: Randomized Complete Block Design
Locations: Arborg (PESAI), Melita (WADO), and Roblin (PCDF)
Treatments: Seven flax cultivars, planted at a seeding rate of 40 lbs/acre.
Varieties: Batsman, Biltstar, CDC Bethune, LG Aquarius, LG Lion, OVB 0815-02, OVB 1001-01
Data collected: Yield, plant height at maturity, days to maturity, flowering period

Agronomic information
Stubble, soil type: Arborg – fallow, heavy clay soil; Melita – wheat/oats/sunflowers, Waskada loam; Roblin – oat/barley silage, Erickson clay loam

Table 1: Applied Treatment List

			Fertility (lb/acre)					
Location	**Plot Size**	**Seeding Date**	**Available**	**Applied**	**Herbicides**	**Spray Date**	**Desiccation Date**	**Harvest Date**
Arborg	9.12m²	15-May	104 N 30 P 680 K	50 N 20 P	Curtail M @ 0.8L/acre Centurion @ 0.075L/acre Reglone @ 0.7L/acre	10-Jun	06-Sep	16-Sep
Melita	12.96m²	06-May	81 N 10 P 192 K	108 N 35 P 20 K	Select @ 0.120L/acre Basagran Forté @ 0.91L/acre	10-Jun 18-Jun	--	29-Aug

Roblin	5.98m²	21-May	57 N 26 P 450 K	63 N 12 P	(PRE) Glyphosate @ 0.64L/acre + Authority @ 0.18L/acre Assure II @ 0.3L/acre + Basagran Forté @ 0.9L/acre Reglone @ 1L/acre	24-May 10-Jun	17-Sep	24-Sep

Results
Yield - Yield differences were significant between European-origin lines and the Canadian-origin check, CDC Bethune, at only Melita (2018) and Roblin (2019) sites. At Melita in 2018, two European lines produced less yield than CDC Bethune while at Roblin in 2019, CDC Bethune also yielded significantly more than four of the six European lines (Tables 2 & 3). LG Lion and LG Aquarius were the only European lines to show significant yields similar to CDC Bethune at Melita in 2018 and Roblin in 2019.
Plant height - All three sites reported significant differences in plant height in 2018, with most lines being significantly shorter than CDC Bethune. However, the number of cultivars statistically differing from the check varied from site to site and year to year (Tables 4). Roblin reported significant height differences in 2019, where CDC Bethune was statistically taller that all European-origin cultivars.
Days to Maturity & flowering - The number of days for flax to reach physiological maturity (75% bolls brown and rattling) at Arborg was similar in both 2018 and 2019. Melita and Roblin experienced a greater number of days required to reach the same flax maturity levels in 2019 than 2018, which may have been a factor of rainfall and environmental differences (Tables 5). Length of flowering period rose in 2019 over 2018 (Tables 6).
Quality - Shannon Froese at the CDC, Saskatoon, conducted flaxseed quality analysis for the 2018 crop. Results are shown in Table 9. Higher iodine values are preferred by the industrial use buyers of flaxseed.

Project findings
Dry and drought-like conditions at the test sites contributed to overall lower yields particularly at Arborg site, as evidenced by low commercial yield across the province according to Manitoba Agricultural Insurance Corporation (MASC). Provincial average yields were 26 and 20 bu/acre in 2018 and 2019, respectively, compared to the 10-year average of 22 bu/acre. Rainfall distribution and time of arrival played an important role in crop development, affecting plant height and yield across the three test locations (Tables 2 & 3).

Short-stature flax was a result of continued moisture stress, along with overall thinner than ideal stands and the opportunity for weed competition. European flax lines were consistently shorter when compared to CDC Bethune, ranging from 4 to 10 centimeters shorter than check in both years.

Overall days to maturity (DTM) were +1 to -5 days from the 87 DTM CDC Bethune rating in 2018 (Table 5), while in 2019 all European lines took 6 to 9 days longer than the check. Correspondingly, flowering period in European flax cultivars was +1 to -7 days in variance from the average 21 days of CDC Bethune in 2018 (Table 6). In 2019, flowering period lengthened overall and European cultivars ranged from +4 to -1 days against a check variety flowering length of 34 days.

Table 2. Performance of different flax lines in European flaxseed test during 2018.

		2018 Yield						
		Arborg		**Melita**			**Roblin**	
VARIETY		kg/ha	bu/ac	kg/ha	bu/ac		kg/ha	bu/ac
CDC Bethune		1675.00	26.6	2226.67	35.4	*ab*	2057.00	32.7
OVB 1001-01		1673.67	26.6	2168.67	34.5	*ab*	1959.00	31.1
LG Lion		1717.00	27.3	2313.67	36.8	*a*	1598.33	25.4
Batsman		1559.67	24.8	1973.00	31.4	*cd*	1669.67	26.5
LG Aquarius		1357.67	21.6	2156.33	34.3	*b*	1518.00	24.1
OVB 0815-02		1361.67	21.7	2116.33	33.6	*bc*	1564.67	24.9
Biltstar		1447.33	23.0	1840.00	29.3	*d*	1608.33	25.6
	GRAND MEAN	**1541.72**	**24.5**	**2113.52**	**33.6**		**1710.71**	**27.2**
	CV %	**9.1**		**3.7**			**14.8**	
	LSD	**-**	**-**	**140.80**	**2.2**		**-**	**-**
	Sign Diff	**No**		**Yes**			**No**	

Table 3. Performance of different flax lines in European flaxseed test during 2019.

		2019 Yield						
		Arborg		**Melita**		**Roblin**		
VARIETY		kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	
CDC Bethune		2119.00	33.7	2719.00	43.2	3616.00	57.5	*a*
OVB 1001-01		1885.00	30.0	2798.00	44.5	3166.00	50.3	*bcd*
LG Lion		1960.00	31.2	2704.00	43.0	3464.00	55.1	*ab*
Batsman		1933.00	30.7	2848.00	45.3	3071.00	48.8	*cde*
LG Aquarius		1833.00	29.1	2849.00	45.3	3302.00	52.5	*abc*
OVB 0815-02		1913.00	30.4	2738.00	43.5	2689.00	42.8	*ef*
Biltstar		1844.00	29.3	2758.00	43.9	2792.00	44.4	*def*
	GRAND MEAN	**1926.71**	**30.6**	**2773.43**	**44.1**	**3157.14**	**50.2**	
	CV%	**7.3**		**6.0**		**7.0**		
	LSD	**-**	**-**	**-**	**-**	**395.40**	**6.3**	
	Sign Diff	**No**		**No**		**Yes**		

Table 4. Plant height (cm) comparisons among different flax lines during 2018 & 2019 testing.

VARIETY	**Arborg18**		**Arborg19**	**Melita18**		**Melita19**	**Roblin18**		**Roblin19**	
CDC Bethune	44.0	*a*	44.0	62.0	*a*	57.0	55.3	*a*	64.0	*a*
OVB 1001-01	36.0	*cd*	37.0	51.7	*b*	59.0	55.7	*a*	56.0	*b*
LG Lion	38.0	*bcd*	40.0	51.7	*b*	53.0	46.0	*b*	44.0	*c*
Batsman	40.0	*abc*	37.0	53.3	*b*	58.0	48.0	*b*	50.0	*bc*
LG Aquarius	37.0	*bcd*	38.0	49.3	*bc*	57.0	45.7	*b*	48.0	*c*
OVB 0815-02	36.3	*cd*	35.0	50.0	*bc*	54.0	46.3	*b*	48.0	*c*
Biltstar	41.7	*ab*	39.0	46.0	*c*	49.0	45.3	*b*	49.0	*c*
GRAND MEAN	**39.0**		**38.5**	**52.0**		**55.3**	**48.9**		**51.1**	
CV %	**6.8**			**5.9**			**7.4**		**7.3**	
LSD	**4.7**			**5.5**			**6.4**		**6.7**	
Sign Diff	**Yes**		**No**	**Yes**		**No**	**Yes**		**Yes**	

Table 5. Days to physiological maturity during 2018 & 2019 testing.

Variety	Arborg18	Arborg19	Melita18	Melita19	Roblin18	Roblin19	Average18	Average19
CDC Bethune	95	92	84	92	82	84	87	89
OVB 1001-01	98	91	86	96	81	105	88	98
LG Lion	94	92	85	93	79	106	86	97
Batsman	91	90	84	95	77	101	84	95
LG Aquarius	90	91	83	98	74	102	82	97
OVB 0815-02	91	90	84	99	79	104	85	98
Biltstar	91	92	84	100	76	119	84	104

Table 6. Length of flowering period (in days) during 2018 & 2019.

Variety	Arborg18	Arborg19	Melita18	Roblin18	Roblin19	Average18	Average19
CDC Bethune	29	37	22	11	32	21	34
OVB 1001-01	31	39	25	11	34	22	37
LG Lion	20	37	15	10	29	15	33
Batsman	13	39	22	11	33	15	36
LG Aquarius	16	39	17	11	39	15	39
OVB 0815-02	16	39	22	12	34	17	36
Biltstar	16	39	12	13	33	14	36

No data from Melita during 2019.

Table 7. Precipitation and Growing Degree Day Seasonal Summary for 2018.

	2018 Growing Season Summary					
	Arborg		**Melita**		**Roblin**	
ENVIRONMENTAL VARIABLE	Actual	Normal	Actual	Normal	Actual	Normal
Seeding Date to Harvest Date						
Precipitation (mm)	217	270	164	256	431	279
Growing Degree Days (base 0°C)	1543	1408	1706	1529	1331	1314
Seeding Date	22-May		07-May		22-May	
Desiccation Date	06-Sep		09-Aug		14-Sep	
Harvest Date	20-Sep		14-Aug		11-Oct	

Table 8. Precipitation and Growing Degree Day Seasonal Summary for 2019.

	2019 Growing Season Summary					
	Arborg		**Melita**		**Roblin**	
ENVIRONMENTAL VARIABLE	Actual	Normal	Actual	Normal	Actual	Normal
Seeding Date to Harvest Date						
Precipitation (mm)	154	274	272	284	229	262
Growing Degree Days (base 0°C)	1373	1430	1331	1382	1283	1292
Seeding Date	16-May		06-May		21-May	
Desiccation Date	06-Sep		-		17-Sep	
Harvest Date	16-Sep		29-Aug		24-Sep	

Table 9. 2019 European flaxseed quality analysis by fatty acid content and iodine value.

VARIETY		2019 Quality Results						
	OMEGA LEVEL			**Ω-9**	**Ω-6**	**Ω-3**	**Ω-9**	
VARIETY	**FATTY ACID (%)**	**Palmitic C16:0**	**Stearic C18:0**	**Oleic C18:1**	**Linoleic C18:2**	**α-Linolenic C18:3**	**Eicosenoic C20:1**	**Iodine Value**
CDC Bethune		6.00	3.8	18.75	17.5	53.94	0.0	187.57
OVB 1001-01		5.55	5.0	21.17	23.3	44.94	0.1	176.09
LG Lion		6.08	4.1	18.65	14.0	57.15	0.0	189.73
Batsman		6.39	4.2	18.50	14.4	56.39	0.1	188.35
LG Aquarius		5.82	3.8	18.21	15.6	56.53	0.0	190.53
OVB 0815-02		6.59	5.0	18.19	13.9	56.22	0.1	186.71
Biltstar		5.50	5.1	17.52	15.3	56.52	0.1	189.31
	GRAND MEAN	5.99	4.4	18.71	16.3	54.53	0.0	186.90

Linseed Flax Coop Variety Evaluation

Project duration: May 2019 – September 2019
Objectives: To evaluate pre-registration varieties for the Linseed Coop.
Collaborators: Helen Booker – University of Saskatchewan Plant Sciences Flax Breeder
Ken Jackle – Crop Development Centre Flax Breeding Program

Background/References/Additional Resources
The trial was conducted in partnership with Helen Booker and the Prairie Recommending Committee for Oilseeds (PRCO). For further information, contact helen.booker[at]usask.ca.

Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 20
Seeding: May 22
Harvest: Sept 17

Table 1: Varieties included in trial at Roblin 2019

CDC Bethune	AAC Prairie Sunshine	FP2591
AAC Bright	CDC Dorado	FP2592
CDC Glas	FP2566	FP2593
Topaz	FP2567	FP2594
CDC Buryu	FP2573	FP2595
AAC Marvelous	FP2589	ND Hammond
CDC Rowland	FP2590	

Data collected	**Date collected**
Height:	Aug 15
Determinate Habit:	Aug 26 – Sept 17
Dry down Habit:	Aug 26 – Sept 17
Maturity:	Aug 26 – Sept 17
Lodging:	Sept 17
Yield:	Sept 17
Moisture:	Sept 17

Agronomic info
Previous year's crop: Quinoa
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Heavy harrowed twice

Table 2: Spring 2019 Soil Test

	Available	Needed
N	54 lb/ac	120 lb/ac
P	13 ppm	12 lb/ac

K	228 ppm	-

Table 3: Added N and P

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	132.3	60.88	-
11-52-0-0	19.23	2.12	10
Total	-	63	10

P banded with seed; N side-banded

Table 4: Pesticide Application

Stage	Date	Product	Rate
Pre-emerge	May 24	Glyphosate	0.64 L/ac
		Authority	0.18 L/ac
	Jul 19	Quizalafop	0.3 L/ac
		Bentazon	0.9 L/ac
Desiccation	Sept 17	Reglone	1 L/ac

Results

The following results are drawn from the Yield Report prepared by Helen Booker's team.

Table 5: Yield as a percentage of CDC Glas at Roblin, 2019

Category	Entry name	Percentage of CDC Glas
Checks	CDC Bethune	117
	AAC Bright	108
	CDC Glas	100
SVPG Entries	CDC Buryu	120
	CDC Dorado	99
	ND Hammond	107
	AAC Marvelous	116
	AAC Prairie Sunshine	108
	CDC Rowland	105
	Topaz	105
3rd Year Entries	FP2566	125
	FP2567	117
	FP2573	132
1st Year Entries	FP2589	112
	FP2590	126
	FP2591	130
	FP2592	129
	FP2593	132
	FP2594	117
	FP2595	124

Montra Hemp Evaluation

Project duration: May 2019 – September 2019
Objectives: To evaluate the effect of Montra products on hemp production.
Collaborators: Kevin Shale – Montra Crop Science

Project findings

The application of the Montra products on hemp did not appear to influence grain yield, emergence or nutrient content significantly. However, both Montra products appear to have significantly affected hemp cannabinoid profiles, specifically for CBG. Other cannabinoids were not significantly affected.

Background

Montra BR-X (a liquid product) and VX-3 (a dry product) were applied to hemp at seeding. MX-3 was applied to both treatments at herbicide application. Plant samples for each treatment were tested for nutrient content.

Materials & Methods

Experimental Design:	RCBD
Entries:	3 (control, BR-X, VX-3)
Seeding:	June 4, 2019
Harvest:	Oct 2, 2019
Variety:	CRS-1

Agronomic information

Previous year's crop:	Oats
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed twice

Data collected	**Date collected**
Emergence:	June
Emergence date:	June 9-11
Cannabinoid harvest:	August 23

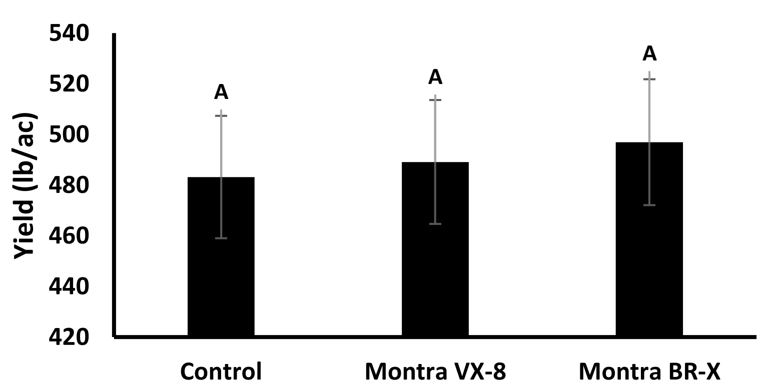


Figure 1: Grain yield for hemp across treatments (treatments marked with the same letter are not significantly different from others in this study)

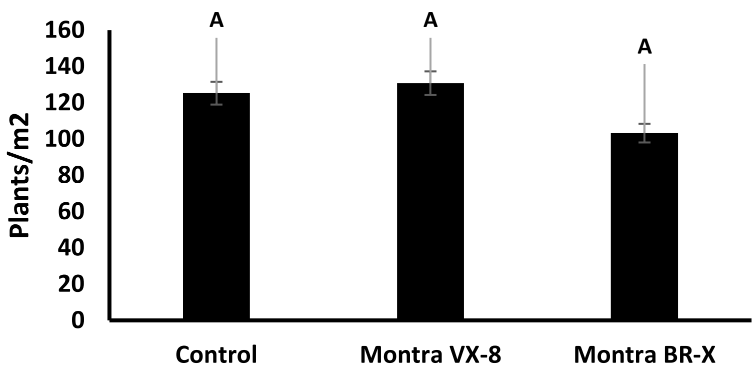


Figure 2: Plant emergence for hemp across treatments (treatments marked with the same letter are not significantly different from others in this study)

Table 1: Spring 2019 Soil Test

	Available	Needed
N	79 lb/ac	120 lb/ac
P	13 ppm	40 lb/ac
K	222 ppm	-

Table 2: Added N and P

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	89	41	0
11-52-0-0	76	8	40
Total	-	49	40

N side-banded; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 19	Heat	28.4 g/ac
		Round-up	0.64 L/ac
In-crop	June 19	Quizalofop	0.3 L/ac
	July 15	Brotex	0.4 L/ac
		Centurion	0.15 L/ac

Table 4: Cannabinoid profile between treatments (% w/w of dry material)

Treatment	**CBD**	**CBDa**	**CBG**	**CBGa**
Control	0.21	0.68	0.01	0.03
BR-X	0.13	0.50	0.02	0.06
VX-3	0.14	0.78	0.01	0.05

National Industrial Hemp Fibre and Grain Variety Evaluation

Project duration: May 2019 – October 2019
Objectives: To evaluate industrial hemp varieties for grain, fibre and cannabinoid content for the National Industrial Hemp Variety Evaluation Trial
Collaborators: Canadian Hemp Trade Alliance

Background
The industrial hemp industry has developed around grain and fibre use. With changes to Canadian legislation around industrial hemp in 2018, the CHTA trials enhanced their protocols around cannabinoid testing.

There were a number of new developments in Canadian legislation in 2018 which very directly affected Canadian hemp growers. The CHTA website outlines these new developments, specifically the changes in Cannabis legislation as well as Health Canada's revision of Section 56 of the Controlled Drugs and Substances Act (CDSA). These changes now allow hemp farmers to immediately collect and store industrial hemp flower, bud and leaf material, a vital piece that was previously prohibited. However, ongoing debate continues to discuss how to classify hemp cannabinoids in relation to the better known recreational cannabis and whether to classify and regulate it as a medical drug. CHTA and Canadian Health Food Association continue to call on the Canadian government to improve the legislation in to allow Hemp cannabinoids to legally fill the gap that illegal sources are currently filling. Figure 1 shows the trichomes on leaf and bud material.

Figure 1: Hemp leaf and bud material showing trichomes.

Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 7 Grain entries and 7 Dual Purpose entries with 4 replications
Seeding: June 10
Harvest: Oct 2

Table 1: Hemp Varieties

Grain only	Dual Purpose (grain and fibre)
CFX-2	Anka
X59	Altair
Katani	CRS-1
Grandi	Petera
CRS-1 (check)	Rigel
Earlina	Santhica 27
Judy	Santhica 70

Data collected	**Date collected**
Emergence:	Jun 19-22
Mortality plant counts:	With emergence
Stem Elongation plant counts:	July 15
Flowering:	Jul 25 – Aug 6
Height:	Aug 22
Lodging:	Oct 2
Yield:	Oct 7
Moisture:	Oct 7

Agronomic info

Previous year's crop:	Barley
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed twice

Table 2: Spring 2019 Soil Test

	Available	Needed
N	79 lb/ac	120 lb/ac
P	13 ppm	40 lb/ac
K	222 ppm	10 lb/ac
S	42 lb/ac	5 lb/ac

Table 3: Added N and P Fertilizer

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	70.7	32.5	0
11-52-0-0	76.9	8.5	40
Total	-	41.0	40

N side-banded; P Banded with seed

Table 4: Herbicide Application

Crop stage	Date	Product	Rate

Pre-emerge	May 19	Heat	28.4 g/ac
		Round-up	0.67 L/ac
In-crop	Jun 20	Brotex 240	0.5 L/ac
		Centurion	0.15 L/ac

Results

Results for the 2019 will be made available through the CHTA website and shared on the Diversification Centres website when available.

Fruit Demonstration

Established May 2009
Objectives To demonstrate varieties of fruits being developed by the University of Saskatchewan
Collaborators Bob Bors – University of Saskatchewan Project Leader Domestic Fruit Program

Background
Dwarf sour cherries are not a native crop to the Canadian Prairies. They are the product of a number of crosses were initially begun by Dr. Les Kerr of the University of Saskatchewan by crossing a cold hardy cherry from Siberia, *Prunus fruiticosa,* with a sour cherry originating in Europe (brought over by settlers) by the name of *Prunus cerasus.* Since then the development has continued by incorporations of other cherries and by the use of dwarfing root stalks. The advantage of the dwarfing root stalk is that it forces earlier fruiting from the plant and it also creates a more workable tree when harvesting, for both manual and mechanical pickers. Dwarf sour cherries constitute the very typical "cherry pie filling" cherry.

The Haskap berry was introduced to Canada around 1967 and now grows across the country, thanks to new varieties developed by the University of Saskatchewan. Fruit growers should consider planting Haskap berries in their orchards because they attract fewer pests and require little maintenance. Manitoba and the rest of the Canadian prairies are a natural fit for Haskap because of its cold craving nature. Haskap is also the first berry to ripen and pickers can enjoy the berry beginning in the mid-June. Haskaps have a sort of blueberry/raspberry feel to them – tart, but perfect for baking.

Birds are of course a problem for both of the above fruits and appropriate measures must be taken to prevent the loss of berries.

Results
A new bird netting setup enabled much higher yield results in the Sour Cherries for 2019. Unfortunately the haskaps came into fruit before the structure was complete, so yields for them were almost zero. A comparative chart below shows successive yields since 2016.

Materials & Methods
Entries: 4 Haskap varieties; 5 Dwarf Sour Cherry varieties
Agronomic info
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Planted: June 2009

Table 1: Dwarf Sour Cherry and Haskap Varieties

Haskap	Cherry
Borealis	Valentine
Tundra	Romeo
9-92	Juliet
9-15	Carmine Jewel
	Cupid

Figure 1: Roblin Haskap Performance 2016-2019

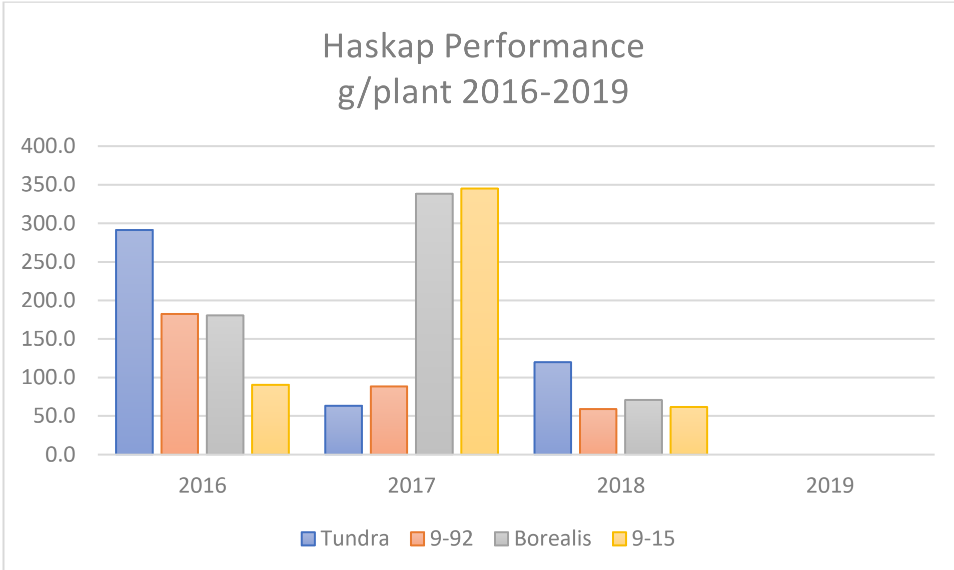
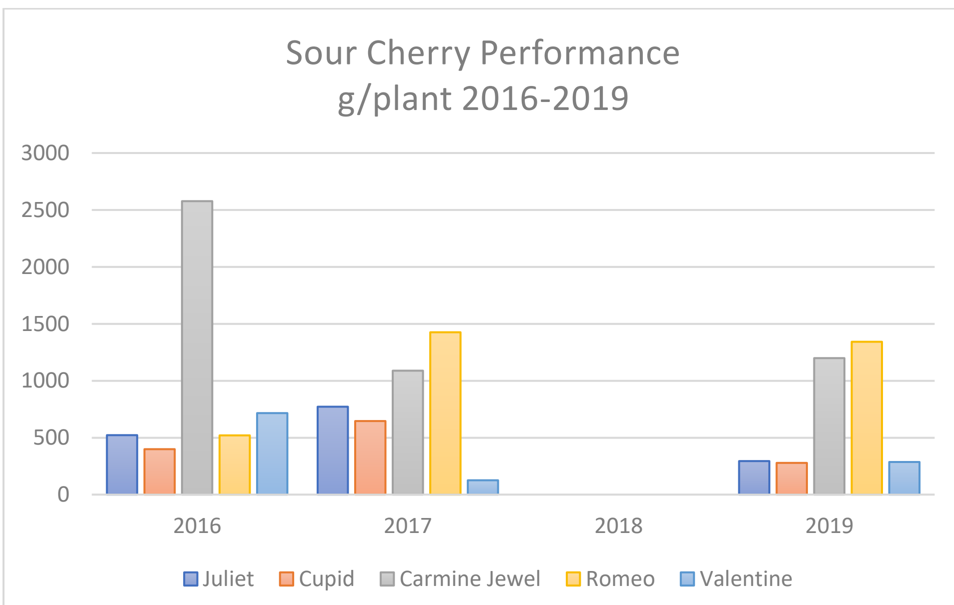


Figure 2: Roblin Sour Cherry Performance 2016-2019



Hopyard Variety Evaluation

Established: May 2018
Objectives: To evaluate varieties of hops for production on the Prairies
Collaborators: James Frey – Diversification Specialist, Manitoba Agriculture
Jessica Frey – Research Technician, PCDF

Background/References/Additional Resources
Production of hops is a growing interest in Manitoba. This is especially true as interest in Winnipeg and other cities surrounding locally sourced grains and hops for their craft brews continues to grow. Entrepreneurs in this industry all say that there is definitely room for more growers and as such Manitoba Agriculture seeks to establish a demonstration for interested parties.

Diversification does not only take place a field scale, and horticultural opportunities such as hops provide alternatives for smaller acreage owners. Growers of hops all describe the spicy sweet scents of ripening hops. They are extremely fragrant and the different varieties each offer different qualities to the beers that are produced from them. Equipment for planting and harvesting are available. An August article in the *Manitoba Cooperator* described how hops growers received funding through the Canadian Agricultural Partnership (CAP) for harvesting equipment.

Hops quickly grow up to 19 feet in length by the end of June and working to get them properly strung up can provide for very busy work in the first part of the growing season. Once harvested, they are ideally pressed into pellets which are the preferred form for brewers. Some growers are looking at providing this service for other growers and others have devised their own means of producing pellets. The size of the operation will determine what is needed for individual growers.

Materials & Methods
Entries: 6 varieties in 3 repetitions
Varieties: See Table 1

Table 1: Hops Varieties at Roblin

Chinook	Willammette
Centennial	Nugget
Golden	Cascade

Agronomic info
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Planted: June 2018
Added Fertility: Composted sheep manure

Project findings: Infrastructure came into place toward the end of the season for the hops to grow upward in their characteristic manner. No harvest or data occurred for 2019.

Phillex Quinoa Variety Trial

Project duration: May 2019 – October 2019
Objectives: To demonstrate the use of cover cropping strategies
Collaborators: Percy Phillips, Phillex Quinoa

Results
Figure 1 shows the average grain yield by variety and the mean yield for all varieties.

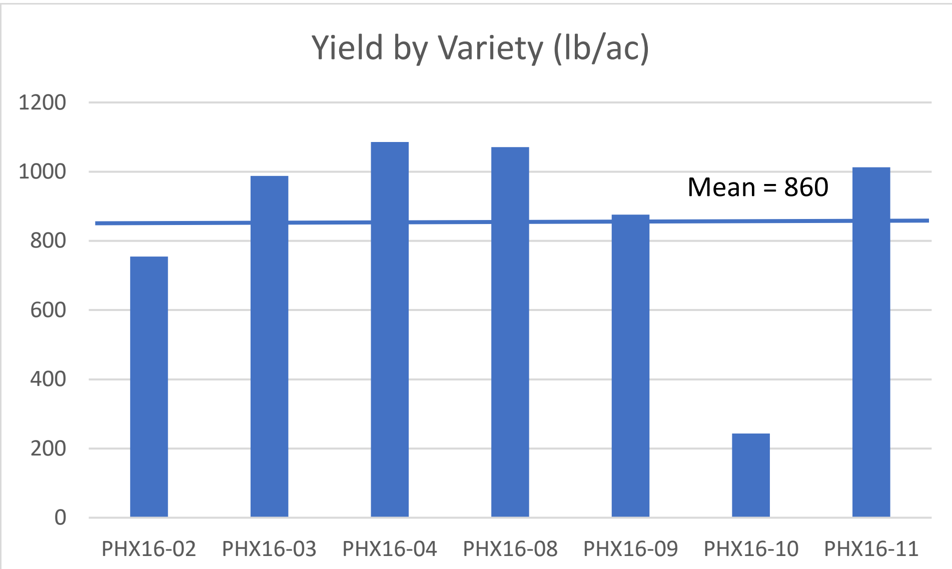


Figure 1: 2019 average yield by variety and mean for all varieties.

Background
PCDF collaborates with Percy Phillips of Phillex, Ltd. to examine the potential of new quinoa varieties for production in Manitoba. The yields observed for 2019 were low in comparison to previous years, due in large part to poor conditions for crop establishment. The first 24 days after planting saw high winds and just 30% of the normal precipitation for the period. Consequently, emergence was not uniform across the plots and yields were generally lower than those observed in other years.

Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 7
Seeding: May 22
Harvest: Sept 25

Agronomic info
Previous year's crop: Soy
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Heavy harrowed twice

Table 1: Treatments

PHX16-01	PHX16-08
PHX16-02	PHX16-09
PHX16-03	PHX16-10
PHX16-07	

Data collected	**Date Collected**
Emergence:	May 30
Height:	Aug 19
Vigor:	Mid Jul
Yield:	Oct 7
Moisture:	Oct 7

Table 2: Spring 2019 Soil Test

	Available	Needed
N	74 lb/ac	130 lb/ac
P	15 ppm	25 lb/ac
K	189 ppm	10 lb/ac

Table 3: Added Fertility

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	117.1	53.88	0
11-52-0-0	19.23	2.12	10
Total	-	56.0	10

N sidebanded: P banded with seed

Table 4: Herbicide Application

Crop stage	**Date**	**Product**	**Rate**
Pre-emerge	May 23	Glyphosate	640 ml/ac
In-crop	June 10	Coragen	50 ml/ac
	June 19	Quizalafop	300 ml/ac
		Lagon	250 ml/ac
	July 19	Decis	150 ml/ac
	August 2	Coragen	60 ml/ac
	August 21	Coragen	60 ml/ac
Desiccation	September 17	Reglone	1 L/ac

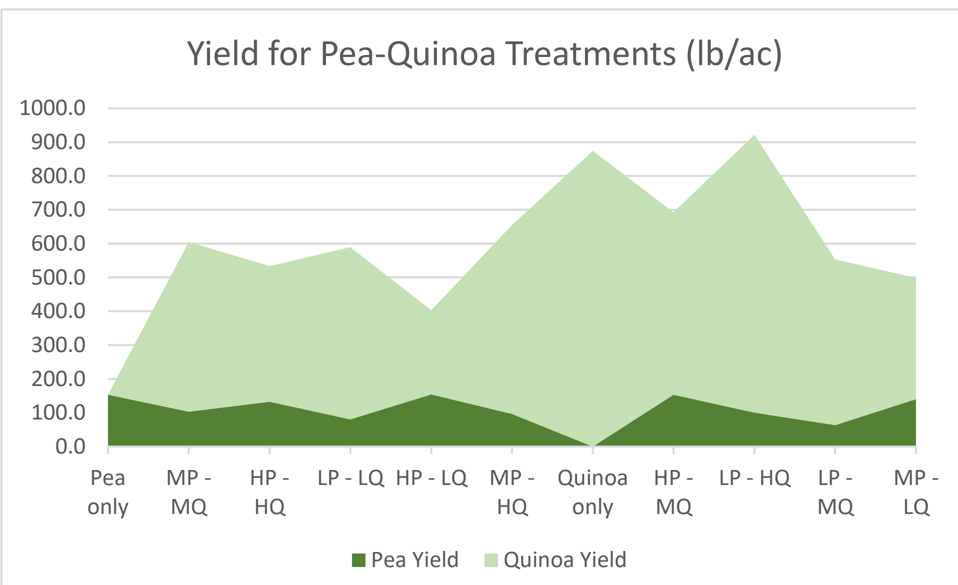
Tamarack Farms Pea-Quinoa ("Peanoa") Intercrop

Project duration: May 2019 – August 2019
Objectives: To demonstrate the use of cover cropping strategies
Collaborators: Ryan Pengelly, Tamarack Farms

Results

Plots were combined and the pea and quinoa crops were separated and examined for yield. Average yields for each treatment are shown in Table 1. Total yields for each treatment are shown in Figure 1.

	Pea	Quinoa	Pea
Avg by trt	lb/ac		bu/ac
Pea only	153.2	N/A	2.55
MP - MQ	103.0	501.9	1.72
HP - HQ	132.9	400.6	2.22
LP - LQ	80.7	508.3	1.35
HP - LQ	154.2	248.4	2.57
MP - HQ	97.0	557.6	1.62
Quinoa only	N/A	873.9	0.00
HP - MQ	153.3	538.9	2.55
LP - HQ	100.3	821.4	1.67
LP - MQ	63.3	490.5	1.06
MP - LQ	139.7	358.8	2.33



Although some treatments out-yielded others, no treatment yielded well. (Pea yields averaged 2 bu/ac, compared to 53-63 bu/ac as a regional average.) However, very dry conditions for about three weeks before and three weeks after seeding resulted in poor, delayed emergence, especially for peas. Delayed emergence resulted in flowering for peas during higher temperatures, causing poor pod-set, reducing yield. Further, several flushes of weeds competed with the crops for moisture.

Background
The trial examines the effect of seeding rate on yield of a pea-quinoa intercrop, using high, medium and low rates for both crops. Proposed benefits of intercropping include: 1) confusion of insect populations; 2) beneficial nutrient interactions such as nitrogen fixation; 3) support for crops prone to lodging; 4) increased combined yields; 5) mitigation of the risk of crop failure; 6) weed suppression; and 7) reduced input requirements and costs.

Materials & Methods

Experimental Design:	Random Complete Block Design
Entries:	11
Seeding:	May 22
Harvest:	Sept 25
Agronomic info	
Previous year's crop:	Soy
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed twice

Table 1: Treatments

Pea only	Low Pea – Low Quinoa	Quinoa only
High Pea-High Quinoa	High Pea-Low Quinoa	High Pea-Medium Quinoa
Medium Pea-Medium Quinoa	Medium Pea-High Quinoa	Low Pea-High Quinoa
Low Pea-Medium Quinoa	Medium Pea-Low Quinoa	

Data collected	**Date Collected**
Emergence:	Jun 12 – Jun 20
Stand Rating:	Mid Jul
Vigor:	Mid Jul

Table 2: Spring 2019 Soil Test

	Available	Needed
N	74 lb/ac	130 lb/ac
P	15 ppm	25 lb/ac
K	189 ppm	10 lb/ac

Table 3: Added Fertility

Blend	Blend (actual lbs/ac)	Actual lbs N	Actual lbs P
46-0-0	117.1	53.88	0
11-52-0-0	19.23	2.12	10
Total	-	56.0	10

N sidebanded: P banded with seed

Table 4: Herbicide Application

Crop stage	**Date**	**Product**	**Rate**
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	June 19	Quizalafop	300 ml/ac
		Lagon	250 ml/ac
	July 19	Decis	150 ml/ac
	August 2	Coragen	60 ml/ac
	August 21	Coragen	60 ml/ac
Desiccation	September 17	Reglone	1 L/ac

Tamarack Farms Quinoa Cover Crop

Project duration: May 2018 – August 2019
Objectives: To demonstrate the use of cover cropping strategies
Collaborators: Ryan Pengelly, Tamarack Farms

Background

Cover cropping is of growing interest to many Manitoba farmers. Cover crops perform a number of significant functions for the soil, including but not limited to controlling soil erosion after the harvest of the cash crop, increasing soil nutrients, and improving water infiltration.

Observations from this trial suggest that planting quinoa with a cover crop may be a beneficial practice. Establishing a cover crop with the quinoa crop would provide a living ground cover during the fall and into the next season (depending on the overwintering habit of the cover crop species). The cover crop could be used for fall or spring grazing, or for use as a green manure before planting the next crop. Alternatively, the cover crop could be harvested for seed. PCDF has plans to try this test again in 2020.

Materials & Methods

Experimental Design: Random Complete Block Design
Entries: 11
Seeding: June 13, 2018
Harvest: 2018: no quinoa harvest; 2019: understory crops harvested Oct 22

Table 1: Understory Crops

Persian Clover	Subterranean Clover	Italian Ryegrass	Alfalfa
White Clover	Alsike Clover	Fall Rye	Quinoa only
Red Clover	Yellow Sweet Clover	Cicer Milk Vetch	

Data collected	**Date Collected**
Vigor:	June 25, 2018
Understory Harvest:	Oct 23
Understory Yield:	Oct 28

Agronomic info

Previous year's crop: Barley Silage
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Tilled and harrowed

Table 2: Spring 2018 Soil Test

	Available
N	54 lb/ac
P	13 ppm
K	228 ppm
S	118 lb/ac

Added Fertility
10 lbs/ac seed placed actual P; 2.11 lbs/ac side banded actual N

Results
In 2018, quinoa was planted with cover crops (see Table 1). Insect damage (especially from stem borer) resulted in no quinoa yield in 2018. The cover crops, however, established well. It is uncertain how the cover crops would have performed if the quinoa crop had performed well, increasing competition for water and sunlight. Additional research is needed to determine the performance of annual and perennial cover crops planted with quinoa.

Pea-Cereals Intercrops for Silage Production

Project duration: May 2019 – October 2019
Objectives: To evaluate the potential for intercropping with peas
Collaborators: James Frey – Diversification Specialist, Manitoba Agriculture
Jessica Frey – Research Technician, PCDF

Background
The use of corn and barley for silage is well-established in the Parkland region and beyond. Interest in producing high-yielding, high-value silage crops has motivated researchers and farmers to experiment with mixtures of annual cereals and legumes.

The cost of seed is higher for corn silage over cereal silage. The Manitoba Agriculture 2020 cost of production for corn silage estimates the cost of corn seed and treatment at $92.80/ac, over $16.88/ac for barley. Producers are motivated to pay higher seed costs for higher anticipated yields for corn silage (averaging 13.03 t/ac for corn over 4.77 t/ac for barley).

Generally, previous studies have found that the dry matter yields for silage mixtures are highest for cereals-only mixtures, and lower when a legume such as pea is included in the mixture. However, including legumes in the mixture can increase crude protein values for silage.

Table 3 shows how the different treatments (Table 1) relate to the nutritional requirements of a breeding herd.

Table 3: Treatments in Relation to Breeding Herd

Class	Crude protein (%)	TDN (%)	Ca (%)	P (%)
Mature cows				
Mid gestation	7	50-53	0.20	0.20
Late gestation	9	58	0.28	0.23
Lactating	11-12	60-65	0.30	0.26
Replacement heifers	8-10	60-65	0.30	0.22
Breeding bulls	7-8	48-50	0.26	0.20
Yearling bulls	7-8	55-60	0.23	0.23

(E. Nernberg, MB Ag & Resource Development)

Materials and Methods
Experimental Design: Random Complete Block Design
Entries: 7
Varieties: Barley: Maverick, Austenson; Oat: Haymaker, Summit; Pea: Lacombe
Seeding: May 16
Harvest: Swathed at 65% moisture

Treatments
Seven treatments were examined, and the seeding rate varied by treatment, according to Table 4. The seeding rates for each treatment were determined following research done by the AAFC Lacombe Research Centre and others. Table 5 shows seeding costs by treatment.

Table 4: Silage Intercrop Treatments

	Treatments	Percent of monocrop seeding rate	Seeding Rate (lb/ac)
1	Barley (Maverick)	100%	90
2	Barley-barley (Maverick-Austenson)	75%-75%	68-68
3	Barley-pea (Maverick-Lacombe)	25%-100%	22-150
4	Oat-oat (Haymaker-Summit)	75%-75%	68-68
5	Oat-barley(Haymaker-Maverick)	75%-75%	22-150
6	Oat-pea (Haymaker-Lacombe)	25%-100%	22-150
7	Oat-barley-pea (Haymaker-Maverick-Lacombe)	12.5%-12.5%-100%	11-11-150

Table 5: Cost by Treatment

	bu/ac			Cost/bu			
Treatments	A	B	C	A	B	C	$/ac
Barley (Maverick)	1.9	-	-	$7.95	-	-	$14.91
Barley-barley (Maverick-Austenson)	1.4	1.4	-	$7.95	$7.95	-	$22.53
Barley-pea (Maverick-Lacombe)	0.5	2.5	-	$7.95	$12.50	-	$34.89
Oats-oats (Haymaker-Summit)	2.0	2.0	-	$7.45	$6.75	-	$28.40
Oats-barley (Haymaker-Maverick)	2.0	1.4	-	$7.45	$7.95	-	$26.16
Oat-pea (Haymaker-Lacombe)	0.6	2.5	-	$7.45	$12.50	-	$36.07
Oats-barley-pea (Haymaker-Maverick-Lacombe)	0.3	0.2	2.5	$7.45	$7.95	$12.50	$35.48

Data collected	**Date Collected**
Emergence Date:	May 29 – Jun 4
Population:	Jun 11
Biomass Wet Weight:	End of July
Biomass Dry Weight:	Beginning of August
Pest Pressure:	Throughout season

Agronomic info

Previous year’s crop:	Cover crop
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed twice
Herbicides:	Pre-emerge application of glyphosate and Heat

Table 5: Spring 2019 Soil Test

	Available
N	156 lb/ac
P	9 ppm
K	170 ppm

All treatments were fertilized with 20 lb/ac actual P.

Results

PCDF tested cereal and pea-cereal mixtures for their potential in producing silage. Table 1 shows the performance of the treatments.

Table 1: Feed Test Values for Silage Intercrop Treatments

Treatment	Yield (% of Check)*	Crude protein (%)**	TDN (%)**	Ca (%)**	P (%)**
Barley only (Check)	100	10.20	67.61	0.37	0.17
Barley-barley	103	11.01	68.62	0.30	0.20
Barley-pea	89	10.55	72.90	0.33	0.17
Oat-oat	88	10.80	69.76	0.29	0.18
Oat-barley	115	12.08	71.29	0.51	0.21
Oat-pea	74	13.40	66.02	0.55	0.22
Oat-barley-pea	83	12.23	69.01	0.54	0.23

* Adjusted to 65% moisture content

** Dry matter content

Overall, mixtures including peas yielded lower than cereals-only varieties. Table 2 shows the comparison of statistical significance for yield, crude protein and TDN.

Table 2: Statistical significance for yield, crude protein and TDN.

Treatment Significantly different from check?	Yield	Crude protein	TDN
Barley only (Check)	N/A	N/A	N/A
Barley-barley	No	No	No
Barley-pea	No	No	Yes ↑
Oat-oat	No	No	No
Oat-barley	Yes ↑	No	Yes ↑
Oat-pea	Yes ↓	Yes ↑	No
Oat-barley-pea	Yes ↓	Yes ↑	Yes ↑

Multi-Crop Intercrop trial (Pea-Oats-Canola-Wheat-Flax-Mustard)

Project duration: 2019-2021
Collaborators: Manitoba Pulse & Soybean Growers Association - Daryl Domitruk
Objectives: Evaluate agronomic performance of peas in a monocrop or when intercropped with oats, canola, spring wheat, flax or mustard

Background

Choice of an intercropping system depends on many factors including: weather, machinery available for seeding, harvesting and separation of seed, economics and compatibility of the crops involved. Many organic agriculture farmers have resorted to various intercropping systems with the aim of addressing weed and disease pressure, which often inhibits organic systems under monoculture situations (Pridham and Entz, 2007). Scientists have been advocating for ways to counteract effects of climate change. Intercropping systems can be one of the ways that can help address climate change in some ways such as biological control of insect pests, weeds and diseases. Biological control allows for less use of synthetic chemicals hence addressing the chemical resistance issues. Another benefit of intercropping is improving soil health at low cost considering residual nitrogen if a legume is included. In other studies, pea-wheat intercropping systems have been shown to be efficient in the use of nitrogen due to their spatial self-regulating dynamics, which allows pea to improve its interspecific competitive ability in fields with lower soil nitrogen and vice versa for wheat (Andersen et al., 2004 and Ghaley et al., 2005). This enables future options to reduce synthetic nitrogen inputs and negative environmental impacts of crop production. Compared to pea sole crop, pea-oats intercrop results in reduced pea lodging because of the support provided by oats to the pea crop, this also helps reduce harvesting difficulties and increase economic returns (Kontturi et al., 2010). This study evaluated various intercrop combinations that can be utilized by producers in different areas of production.

Materials and Methods

Experimental Design: Random Complete Block Design
Entries: 11
Varieties: Pea (Amarillo), Flax (Neela), Oat (Summit), Spring Wheat (Carberry), Canola (5545CL), Mustard (Andante)
Seeding: May 16
Harvest: Sept 25

Table 1: Intercrop Entries

Pea only	Spring Wheat only	Pea-Flax	Pea-Canola
Flax only	Canola only	Pea-Oat	Pea-Mustard
Oat only	Mustard only	Pea-Spring Wheat	

All treatments including peas were inoculated.

Data collected	**Date Collected**
Emergence Plant Count:	May 29
Flowering Plant Count:	Jul 16
Flowering Date:	Jul 2 – Jul 24
Weed/Crop Biomass Ratio:	Jul 15

Seed Separation: Oct 2
Yield: Oct 3-4
Moisture: Oct 3-4
Splits per 500 seeds (pea): Oct 24
Sampling for protein analysis

Agronomic info
Previous year's crop: Flax
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Tilled and harrowed

Table 2: Spring 2019 Soil Test

	Available
N	156 lb/ac
P	9 ppm
K	170 ppm

Results and Discussion
Results from Roblin (Table 3a) indicate that there were no significant differences in partial pea yield, land equivalency ratio (LER) or total land equivalency ratio (TLER) regardless of the intercrop option. At Reston, peas intercropped with canola yielded significantly (P=0.001) more grain resulting also in significantly higher partial pea LER (P=0.001) at 1.22 and higher TLER (P<0.0001) at 2.05 compared to other intercrop options. There were no significant yield differences in other pea intercrop options (Table 3b). At Elva, the highest partial pea yield (2405 kg/ha) obtained from a mustard intercrop was not significantly different from wheat or canola intercrops but was significantly higher (P=0.002) than pea yield obtained from oats and flax plots. Partial pea land equivalence ratio for pea followed the same pattern as yield with mustard intercrop having 0.76 pea LER which was significantly (P=0.001) higher than oats and flax. The TLER for the mustard intercrop was not significantly different from other treatments except flax which had the lowest at 0.94 compared to 1.27 (P=0.022) for the former (Table 3c).

Table 3a. Analysis of variance for yield, partial LER and TLER for Roblin Multi-Crop

Trt	Crop	Yield (kg ha^{-1})			LER		
		Sole	Crop-IC	Pea-IC	Partial Sole	Partial Pea	TLER
1	Pea	939	*	*	1.00	*	1.00a
2,7	Flax	1386	347	869a	0.31	0.87a	1.18a
3,8	Oat	6794	4753	371a	0.71	0.43a	1.15a
4,9	Wheat	4505	2325	371a	0.52	0.44a	0.95a
5,10	Canola	4451	2071	1691a	0.44	1.98a	2.42a
6,11	Mustard	2142	1286	956a	0.61	1.07a	1.68a
	P value			**0.101**		**0.072**	**0.115**
	CV			**81**		**79**	**55**

LER=Land equivalence ratio, TLER=Total land equivalence ratio, IC=Intercrop

Table 3b. Analysis of variance for yield, partial LER and TLER for Reston Multi-Crop

Trt	Crop	Yield (kg ha^{-1})			LER		
		Sole	Crop-IC	Pea-IC	Partial Sole	Partial Pea	TLER
1	Pea	531	*	*	1.00	*	1.00d
2,7	Flax	2463	1681	306b	0.64	0.58b	1.22cd
3,8	Oat	4328	4323	344b	1.01	0.66b	1.67ab
4,9	Wheat	3865	3177	322b	0.83	0.61b	1.44bcd
5,10	Canola	3735	3070	656a	0.82	1.22a	2.05a
6,11	Mustard	2034	1651	401b	0.80	0.76b	1.56bc
	P value			**0.001**		**0.001**	**<0.0001**
	CV			**23**		**23**	**13**

Table 3c. Analysis of variance for yield, partial LER and TLER for Elva Multi-Crop

Trt	Crop	Yield (kg ha^{-1})			LER		
		Sole	Crop-IC	Pea-IC	Partial Sole	Partial Pea	TLER
1	Pea	3301	*	*	1.00	*	1.00ab
2,7	Flax	1865	909	1479bc	0.49	0.45bc	0.94b
3,8	Oat	4173	3390	1079c	0.83	0.35c	1.17ab
4,9	Wheat	2220	1302	1920abc	0.59	0.62ab	1.21ab
5,10	Canola	2602	1255	2258ab	0.51	0.71ab	1.22ab
6,11	Mustard	1318.4	666	2480a	0.51	0.76a	1.27a
	P value			**0.002**		**0.001**	**0.022**
	CV			**22**		**20**	**12**

In 2019, the percentage change in crop emergence and weed biomass was not significantly different at any of the three sites regardless of the intercrop combination. There was no evidence on whether one intercrop had an advantage over the other in suppressing weeds. These results suggest the need for additional site years of data to determine an appropriate intercrop option that producers can use as an alternative integrated weed control strategy in their areas of production (Tables 4a-4c).

Table 4a. Analysis of variance for crop emergence and weed biomass for Roblin Multi-Crop in 2019

Trt	Crop	Final Emergence ppms			% Change Emergence			Weeds (g/m2)	
		Sole	Crop-IC	Pea-IC	Sole	Crop-IC	Pea-IC	Sole	Pea-IC
1	Pea	66	*	*	17	*	17a	93.8	*
2,7	Flax	153	65	49	41	42	14a	274	115a
3,8	Oat	102	84	29	47	15	39a	21.5	81a
4,9	Wheat	99	86	38	51	36	14a	25.75	32.8a
5,10	Canola	58	24	49	35	28	21a	91	35.25a
6,11	Mustard	31	24	48	22	26	0a	123.5	96a
	P value						**0.127**		**0.681**
	CV						**100**		**114**

Table 4b. Analysis of variance for crop emergence and weed biomass for Reston Multi-Crop in 2019

Trt	Crop	Final Emergence ppms			% Change Emergence			Weeds (g/m2)	
		Sole	Crop-IC	Pea-IC	Sole	Crop-IC	Pea-IC	Sole	Pea-IC
1	Pea	77	*	*	13	*	13a	2193	*
2,7	Flax	469	190	41	4	19	13a	920	1274a
3,8	Oat	204	108	29	3	7	28a	1011	1636a
4,9	Wheat	247	106	38	7	3	15a	1302	1756a
5,10	Canola	71	36	33	3	0	29a	893	1026a
6,11	Mustard	33	22	37	0	3	17a	1991	1691a
	P value						**0.534**		**0.094**
	CV						**83**		**33**

Table 4c. Analysis of variance for crop emergence and weed biomass for Elva Multi-Crop in 2019

Trt	Crop	Final Emergence ppms			% Change Emergence			Weeds (g/m2)	
		Sole	Crop-IC	Pea-IC	Sole	Crop-IC	Pea-IC	Sole	Pea-IC
1	Pea	85	*	*	9	*	9a	120	*
2,7	Flax	353	196	41	4	11	10a	53	66a
3,8	Oat	240	129	39	7	7	9a	79	25a
4,9	Wheat	270	133	45	0	5	13a	16	43a
5,10	Canola	77	47	41	16	13	5a	182	59a
6,11	Mustard	86	42	42	6	20	9a	90	40a
	P value						**0.942**		**0.083**
	CV						**113**		**73**

Although there were no significant differences in pea splits at Roblin, there was a significant (P=0.029) difference in protein content with mustard intercrop recording 26.5% compared to 22.3% for the wheat intercrop. Compared to other sites, Roblin recorded higher protein content with a range of 22.3 to 26.5% compared to 21.5 to 22.5% across all intercrop options in 2019 (Table 5). Whereas protein content (21.6 to 22.4%) was not significantly different among different intercropping systems, there were significant (P<0.0001) differences in pea splits at Reston. Pea splits were lowest in oats intercrop (3.5g per 500 seeds) compared to pea monocrop and flax intercrop that had 9.4 and 11.2g per 500 seeds,respectively. At Elva, pea splits were lowest (0.1g per 500 seeds) in oats compared to pea monocrop with 1.8g per 500 seeds (P=0.02). Pea splits in other intercrop options were not significantly different from pea splits in oats and pea monocrop. Pea protein content at the same site was significantly (P=0.014) lower in canola intercrop (21.5%) compared to oat and wheat intercrop (22.5%).

Table 5. Analysis of variance for pea splits and protein content at 3 Multi-Crop sites in 2019

		Reston		Elva		Roblin	
Trt	Crop	Pea splits g/500 seeds	Pea protein % DM basis	Pea splits g/500 seeds	Pea protein % DM basis	Pea splits g/500 seeds	Pea protein % DM basis
1	Pea	9.4ab	22.4a	1.8a	22.2ab	5.8a	24.5ab
2,7	Flax	11.2ab	22.1a	0.4ab	21.8ab	7.8a	24.8ab

3,8	Oat	3.5c	22.3a	0.1b	22.5a	5.1a	23.1ab
4,9	Wheat	5.1c	21.9a	1.7ab	22.5a	8.8a	22.3b
5,10	Canola	5.7bc	22.3a	1.4ab	21.5b	3.5a	23.7ab
6,11	Mustard	7.3abc	21.6a	1.1ab	21.7ab	6.8a	26.5a
	P value	**<0.0001**	**0.193**	**0.02**	**0.014**	**0.211**	**0.029**
	CV	**26**	**2**	**65**	**2**	**47**	**6**

Net revenue obtained from different cropping systems was significantly different (P=0.001 at Roblin and P<0.0001 at Reston and Elva). At Roblin, pea sole crop, pea-flax and pea-wheat resulted in negative net revenues, while pea-oats, pea-canola and pea-mustard recorded the highest net revenues (Table 6a). At Reston, pea sole crop had the lowest net revenue compared to the other cropping systems (Table 6b). There appeared to be significantly higher net revenues when pea was intercropped with oat, canola or mustard than pea sole crop. Net revenue obtained from intercropping pea with flax, oat or wheat was not significantly different (Table 6b). At Elva, net revenue obtained from pea sole crop and pea intercrop with flax, oats or wheat was significantly lower than that obtained from pea-canola or pea-mustard (Table 6c). These results provide some insight on viable options to reduce on-farm financial risk. Higher revenue from pea intercropping systems involving mustard or canola are a promising option. With additional site-years, this study will provide a better understanding of component crop dynamics.

Table 6a. Economic analysis for Roblin Multi-Crop in 2019

		Economics					
Trt	**Crop**	**Sole-CROP**	**IC – CROP**	**Gross Revenue**		**Net Revenue**	
				Sole	**IC**	**Sole**	**IC**
1	Pea	303	*	98	*	(206)	(206)b
2,7	Flax	289	325	281	161	(8)	(164)b
3,8	Oat	292	318	667	506	376	187a
4,9	Wheat	308	316	451	272	143	(44)ab
5,10	Canola	328	339	872	581	544	242a
6,11	Mustard	317	336	725	535	408	199a
	P value						**0.001**
	CV						**411**

Table 7b. Economic analysis for Reston Multi-Crop in 2019

		Economics					
Trt	**Crop**	**Sole-CROP**	**IC – CROP**	**Gross Revenue**		**Net Revenue**	
				Sole	**IC**	**Sole**	**IC**
1	Pea	303	*	55	*	(248)	(248)c
2,7	Flax	289	325	499	373	210	48b
3,8	Oat	292	318	425	461	134	142ab
4,9	Wheat	308	316	387	352	79	36b
5,10	Canola	328	339	732	669	404	329a
6,11	Mustard	317	336	689	601	372	265a
	P value						**<0.0001**
	CV						**28**

Table 7c. Economic analysis for Elva Multi-Crop in 2019

Trt	Crop	Economics					
		Sole-CROP	IC – CROP	Gross Revenue		Net Revenue	
				Sole	IC	Sole	IC
1	Pea	303	*	343	*	40	40bc
2,7	Flax	289	325	378	338	89	13c
3,8	Oat	292	318	410	445	118	127ab
4,9	Wheat	308	316	223	330	(86)	14bc
5,10	Canola	328	339	510	481	182	141a
6,11	Mustard	317	336	446	483	129	147a
	P value						**<0.0001**
	CV						**52**

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Wheat Nitrogen Ramp – (Year 2 of a 6-Year Crop Rotation)

Project duration: Spring 2018 – Fall 2023
Objectives: To assess the economic and agronomic impact of a 6-year rotation, using integrated management practices.
Collaborators: Parkland Crop Diversification Foundation

Project findings
The spring wheat yields shown in Tables 1 indicate a responsiveness to added nitrogen over the amount provided by the green manure in 2018. Table 1 appears to indicate a decrease in yield for treatment 4; however, the reduced yield for that treatment can be attributed to poorer plant establishment in some plots. The dotted, red trend-line shows the general trend for yield.

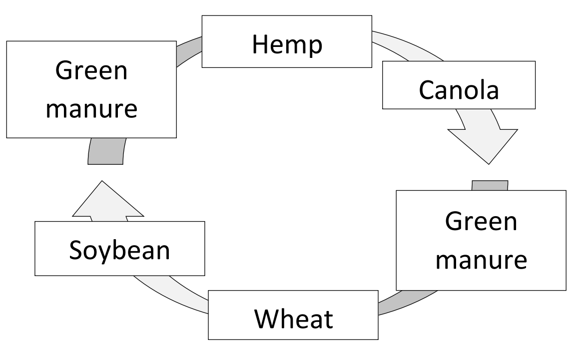
Background
The use of green manures for fertility has the potential to reduce fertilizer inputs during the cropping year. In 2019, wheat was planted after a green manure in 2018. The nitrogen fertility levels between treatments are compared in Table 2, along with the cost of nitrogen additions per treatment.

Table 2: N fertility levels and N costs by treatment

Treatment	Added N	Total N	Cost N/ac at $0.50/lb
1	0.0	115.0	$0.00
2	9.7	124.7	$4.84
3	19.4	134.4	$9.68
4	38.7	153.7	$19.35
5	58.1	173.1	$29.03
6	77.4	192.4	$38.71
7	96.8	211.8	$48.38

Figure 1 shows the full six-year rotation for the trial.

Figure 1: Six-Year Rotation Schematic



Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 7 treatments

Seeding:	May 14
Harvest:	Sept 11

Agronomic info

Previous year's crop:	Green manure blend – oat, pea, Italian Ryegrass, Japanese Millet, Persian Clover, Common Vetch, Sugar Beet, Phacelia, Chicory, Turnip Rape
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Green manure disked into soil fall 2018

Table 2: Treatments

No added Nitrogen	60% added Nitrogen
10% added Nitrogen	80% added Nitrogen
20% added Nitrogen	100% added Nitrogen
40% added Nitrogen	

All treatments seeded with lb/ac actual P

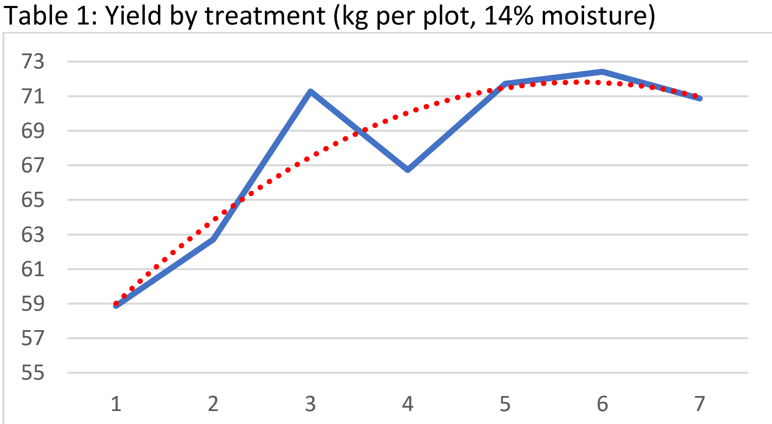
Table 3: Spring 2019 Soil Test

	Available
N	115 lb/ac
P	17 ppm
K	183 ppm

Results

Average yields for spring wheat by treatment are show in Table 1.

Table 1: Yield by treatment (kg per plot, 14% moisture)



The Effect of Grazing and Non-grazing of Annual Green Manures on Following Crops – Establishment Year

Project duration: May 2019 – October 2020

Objectives: To demonstrate the use of an annual green manure crop for grazing by livestock and to provide fertility for the following crop (2019); and to evaluate the performance of three annual field crops after a green manure crop, with and without grazing (2020).

Collaborators: James Frey, Manitoba Agriculture
Jessica Frey, Parkland Crop Diversification Foundation

Background

The cost of the seed blend for forage is high relative to simpler cereal-only annual forages, such as barley planted for green feed (estimated at $16.88/ac in the MB Agriculture Cost of Production). However, the blend used here allows for extended in-season grazing, including swath or bale grazing, reducing pressure of perennial pastures. Some livestock producers in Manitoba have successfully used annual green manures to graze livestock in-field into the winter months, reducing feeding and yardage costs. Other benefits in future years to soil health and crop performance may be observed.

Results

After establishing the green manure crop on May 14, half of the crop was intensively grazed by sheep, and the other half was mowed. The entire area was disked in October, after freeze-up. Table 1 gives details for the green manure blend.

Table 1: Green manure blend by species, rate and description

Species	Rate (lb/ac)	$/ac	Description
Pea (4010 forage)	40	8.33	Cool season legume; forage type
Oat (Haymaker)	30	7.02	Cool season grass; forage/hay type
Japanese millet	3	5.37	Warm season grass
Italian ryegrass	2	4.38	Cool season grass; limited over-wintering ability
Persian clover	2	8.38	Cool season legume; slow establishment
Chicory	0.5	4.79	Short-lived perennial broadleaf; deep taproot
Turnip	0.3	1.44	Cool season broadleaf; good frost tolerance
Feed beet	0.7	4.19	Cool season broadleaf; quick leaf regrowth
Common vetch	2	5.58	Cool season legume; shade tolerant
Phacelia	0.5	2.50	Warm season broadleaf; attracts pollinators
	Total	**51.98**	

The green manure was grazed on August 19. Based on biomass sampling, hay yield was calculated to be 6.5 1500-lb round bales per acre. Crude protein was 11.6% and TDN was 69%. The stocking rate for animals was 195 sheep per acre for 5 days. This equals 39 animal units (1 animal unit = 1000 lb animal).

In 2020, PCDF will plant spring wheat, barley and canola on the grazed and non-grazed areas, as well as on a control where no green manure was established. This will allow for an evaluation of the effect of growing a crop on the three treatments (grazed, non-grazed, no green manure).

Wheat-Cover Crop

Project duration: May 2019 – August 2019
Objectives: To demonstrate the use of cover cropping strategies
Collaborators: James Frey, Manitoba Agriculture
Jessica Frey, Parkland Crop Diversification Foundation

Background
Cover cropping is of growing interest to many Manitoba farmers. Cover crops can be planted alone or with a cash crop, and can perform a number of significant functions for the soil, including controlling soil erosion after harvest of the cash crop, sequestering and increasing soil nutrients, and improving water infiltration. Seeding a cover crop with a cash crop can reduce fieldwork in the following year, allowing the cover crop to be used as a source of fertility (i.e. green manure), forage crop or cash crop.

Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 11 (Table 1)

Table 1: Treatments

Wheat only	Wheat and Persian clover
Wheat and subterranean clover	Wheat and alfalfa
Wheat and red clover	Wheat and Italian ryegrass
Wheat and white clover	Wheat and alsike clover
Wheat and yellow sweetclover	

All treatments seeded with lb/ac actual P

Agronomic info
Previous year's crop: Oat
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Heavy harrowed
Seeding: May 22
Harvest: See "Discussion" below

Data collected	**Date Collected**
Yield:	Sept 20
Moisture:	Sept 20

Table 2: Spring 2019 Soil Test

	Available
N	143 lb/ac
P	20 ppm
K	207 ppm

Added Fertility
10lbs/ac actual P and 2.11lbs/ac actual N

Discussion
Poor emergence resulted in high weed pressure in the trial. PCDF decided to continue the trial for observational purposes only. The wheat was harvested by a small plot combine, although due to poor establishment, the wheat yield was not calculated. Observational notes for the treatments are listed here:

Treatment	Observational notes for cover crop
Wheat only	High weed pressure
Wheat and subterranean clover	Fair growth; compact, low growth.
Wheat and red clover	Minimal growth.
Wheat and white clover	Minimal growth.
Wheat and yellow sweetclover	Minimal growth.
Wheat and Persian clover	Good growth; plants reaching up to flag leaf.
Wheat and alfalfa	Fair establishment, but impeded by weeds
Wheat and Italian ryegrass	Good establishment, but negative impact on wheat establishment.
Wheat and alsike clover	Fair growth.

Oat-Hairy Vetch Intercropping Demonstration (2018-2019) and Seeding Rate Evaluation (2019)

Project duration: May 2018 – September 2019
Objectives: To demonstrate the use of intercropping for grain, forage and soil nutrient management
Collaborators: Parkland Crop Diversification Foundation

Background
Seeding oats with hairy vetch has the potential to improve straw feed values, while not impairing oat grain yield. However, seeding and harvest date and seeding rate are important. If the hairy vetch seeding rate is too high, or if the hairy vetch is allowed to grow too much, harvest for oat grain can be difficult. Earlier seeding (mid- to late-May) provides the oats with a competitive advantage over the hairy vetch and allows the oats to mature sooner in fall. However, earlier seeding combined with a delayed harvest in fall may allow the hairy vetch plants to grow too much, causing serious issues with wrapping, catching on the combine header, and plugging. Using a header with vertical side knives may help to reduce harvest problems.

In 2019, earlier seeding and later harvest dates (as compared to 2018) gave the hairy vetch crop an additional 30 days of growth. Consequently, the hairy vetch for some of the higher seeding rates was extremely thick (see Figure 1). For this reason, harvest was discontinued for the plots and no grain yield was obtained.

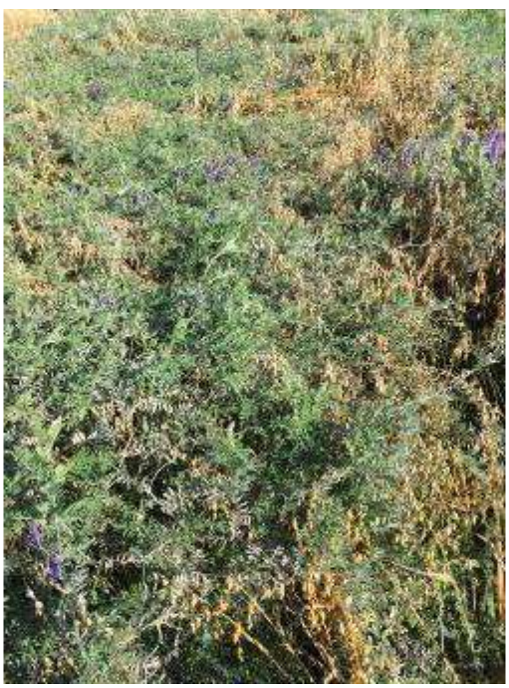


Figure 1: Thick growth of hairy vetch in oats due to high seeding rate (30 lb/ac hairy vetch) and delayed harvest.

Among the rates tested in 2019 (Table 2), hairy vetch rates of 30 lb/ac created harvest problems. However, that rate did not create a problem in 2018, when the crop had less time to grow. Because hairy vetch seed can be costly (around $2/lb), lower rates that are seeded earlier and harvested later may reduce costs, while still contributing a meaningful amount of the hairy vetch in the straw. More work is needed to determine optimum planting and harvest dates, as well as seeding rates.

When present in adequate amounts, hairy vetch improves the feed value of oat straw. Table 2 shows the feed value for the oat-hairy vetch straw harvested in 2018, with comparisons for other forage types.

Table 2: Feed Value of Oat-Hairy Vetch Straw

Feed type	Crude Protein %	TDN %
Hairy vetch plus oat straw	13.33	59.94
Hairy vetch only (comparison)	27.33	69.74
Oat straw only (comparison)	5.44	48.21
First-cut alfalfa-grass (comparison)	13.12	57.57
Recommended requirements for 1400 lb cow, mid-3rd pregnancy	7.00	55.00

Assuming that the hairy vetch is able to over-winter (as in 2018), the crop can be used in several ways: 1) as an early-season forage crop; 2) as a green manure plow-down; and 3) for seed production. In 2019, PCDF harvested the hairy vetch from the demonstration plots for seed, producing 692 lb/ac. Growing hairy vetch for seed can reduce the costs of the system dramatically. The amount of seed harvested from one acre at PCDF is enough to plant 46 acres at 15 lb/ac.

A disadvantage to using hairy vetch is the high level of hard seed, which results in sporadic germination in subsequent years. Some reports show problems for ruminants fed hairy vetch seed (although some show that the risk is minimal). The crop is also resistant against glyphosate, which can cause problems for some rotations, especially for crops of similar seed size and shape (such as soybean).

Agronomic info

Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the west
Seedbed preparation:	Cultivated and harrowed before oat-hairy vetch (2018); no prep in 2019.

Materials and Methods

<u>Demonstration (2018-2019)</u>

Seeding:	Jun 12, 2018
Harvest 1:	Sept 27, 2018 (oat grain)
Harvest 2:	Oct 1, 2019 (hairy vetch seed)

<u>Evaluation (2019)</u>

Seeding:	May 14, 2019
Harvest:	Oct 10, 2019

Fertility

The oat-hairy vetch for both the demonstration and evaluation was planted with 10 lb/ac actual P and 2.11 lb/ac actual N. The hairy vetch was inoculated, and no N was added to the demonstration in 2019.

Table 3: Spring Soil Test

	Available	
	Demonstration (2018)	Evaluation (2019)
N	150 lb/ac	156 lb/ac
P	23 ppm	9 ppm
K	181 ppm	170 ppm

Results

Demonstration (2018-2019)

The data presented here are for two years of demonstration: oat grain yield and oat-hairy vetch straw feed values (Year 1) and hairy vetch seed production (Year 2).

In 2018, establishment for the oat-hairy vetch intercrop was successful. Despite high oat yields, there was virtually no lodging in the oats, as the hairy vetch appeared to provide structural support. The intercrop was straight-combined. The hairy vetch plants had not produced over-abundant amounts of plant material, and as a result, the oat-hairy vetch straw passed through the combine without wrapping. The harvested grain was cleaned to remove green leaf material from the hairy vetch.

In 2019, regrowth of the hairy vetch plants began in mid-April, and flowered in late July. Harvest of the hairy vetch seed occurred on October 1. Table 1 shows yield for 2018-2019.

Table 1: Yields for 2018-2019 Oat-Hairy Vetch Intercrop Demonstration

Type (Year)	Yield
Oat grain (2018)	100.7 bu/ac
Oat-hairy vetch straw (2018)	Yield not recorded
Hairy vetch seed (2019)	692 lb/ac

Seeding Rate Evaluation (2019)

In 2019, PCDF established test plots to evaluate different seeding rates for intercropping of oat and hairy vetch. Table 2 shows the seeding rates for that test.

Table 2: Seeding Rates for 2019 Oat-Hairy Vetch Intercrop Evaluation

Treatment	Rate (lb/ac)
Oat only	45
Oat only	90
Oat-hairy vetch	90-30
Oat-hairy vetch	90-15
Oat-hairy vetch	90-5
Oat-hairy vetch	45-30
Oat-hairy vetch	45-15
Oat-hairy vetch	45-5
Hairy vetch only	30
Hairy vetch only	15
Hairy vetch only	5

PCDF

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