Agriculture Demonstration of Practices and Technologies (ADOPT)
Project Final Report

The final project report should be made available electronically (MS Word). Additional data tables and or graphs may be submitted in spreadsheet format. Due to formatting, printing and distribution requirements, final reports will not be accepted as PDF documents. Completed reports must be returned by email to Evaluation.Coordinator@gov.sk.ca.

Project Title:	Expanding Rotational Options Using New and Novel Pulse Crops 2.0
Project Number:	20220523
Producer Group Sponsoring the Project:	Saskatchewan Pulse Crop Development Board (SPG)
Project Location(s):	Swift Current (R.M. #137), Indian Head (R.M. #156), Scott (R.M. #380), Melfort (R.M. #428), Prince Albert (R.M. #481), Outlook (R.M. #284), Yorkton (R.M. #244), Redvers (R.M. #61).
Project start date *(month & year):*	4/30/2023
Project end date *(month & year):*	2/28/2024

Project Manager Contact

Full Name:	Amber Wall
Organization:	Wheatland Conservation Area
Mailing Address:	PO Box 2015, Swift Current, SK. S9H 4M7
Phone Number:	306-773-4775
E-mail:	wcawall@sasktel.net

Abstract *(maximum 200 words)*

In 2023, field trials were conducted at eight Saskatchewan locations including Swift Current, Indian Head, Melfort, Outlook (irrigated), Prince Albert, Redvers, Scott and Yorkton. The objective of the demonstration was to provide producers with basic economic and agronomic information on non-traditional pulse crops that may be adapted to the various regions in the Agri-ARM network, specifically fenugreek and lupin. Introducing new and novel pulse crops into specific regions is necessary to maintain, diversify, and extend cropping rotations leading to a more robust integrated pest management cropping system. Each crop was replicated four times in a split block design and compared to a pulse 'reference' crop (either peas, or lentils) to ensure a good visual representation and quality data. A pre-seed herbicide registered for all crops was applied and

weeds were controlled using a combination of registered pre-seed and in-crop herbicides. Inoculants were limited for many of these pulse crops, so nitrogen fertilizer was applied according to a general soil test where inoculant was not available. Many of the Agri-ARM sites featured this demonstration during their annual field days.

Project Objectives

The objective of this demonstration was to provide producers with basic economic and agronomic information on non-traditional pulse crops that may be adapted to the various regions in the Agri-ARM network, specifically fenugreek and lupin. Introducing new and novel pulse crops into specific regions is necessary to maintain, diversify, and extend cropping rotations leading to a more robust integrated pest management cropping system.

Project Rationale

Extending cropping rotations has long been promoted in the province by many commodity groups, industry, and government organizations to help producers develop a more robust integrated pest management system. Identified as a priority issue by the Saskatchewan Pulse Growers, incorporating new pulse crop options will maintain or diversify pulses in a crop rotation, particularly in regions that are experiencing production issues with over utilization of current pulse crops. Specifically, this project aimed to begin evaluating the regional adaptation of fenugreek and lupin. These novel pulse crops can provide growers with additional cropping options for producers facing pea and lentil production challenges, such as aphanomyces and fusarium root rots, fungicide resistant anthracnose.

The project expanded on similar demonstrations that were done in the past, including in 2022 at all Agri-ARM sites, who have all indicated there was, and remains, great interest from producers on new and novel pulse crops. These demonstrations have proved to be popular stops on the field days and tours, generating questions, follow-up inquiries regarding agronomic and economic concerns from industry partners, farmers, ministry and commodity group staff. Of the crops included in the 2022 ADOPT demonstration, fenugreek, lupin, and dry beans were of utmost interest to those visiting, and some of the most successful in terms of emergence, development and weed control. The Saskatchewan Pulse Growers have expressed this is a top priority area that more information is needed, specifically on establishment, herbicide applications, and general management and adaptation details.

The Saskatchewan Pulse Growers have received feedback from their producer members concerned with agronomic and economic issues related to pulse crops in their cropping rotations. Including a pulse crop in rotation with cereals and oilseed crops is shown to increase soil available nitrogen, improve soil health, and optimize soil moisture, resulting in increased yields of subsequent crops using less nitrogen and optimizing economic returns.

However, in order to ensure diversity, producers must have multiple cropping options available to them in each phase of the rotation and before introducing a new crop into an existing rotation, producers must do extensive research into the crops agronomic and environmental requirements in order to grow it. This must be followed up by researching market opportunities and commodity pricing to ensure positive economic returns. Even though many producers are willing to take these steps, they lack specific information on growing and marketing new crops in their particular region. This becomes a major deterrent to many, which limits the adaption of new and novel pulse crops and restricts diversity of rotations. Adapting new pulse crops that are tolerant or resistant to current production issues facing pea and lentil acres like aphanomyces and fusarium species root rot, can provide growers with much needed options to maintain rotational diversity. Testing agronomic practices in crops like fenugreek and lupin will provide growers insight into the suitability these crops across the range of Saskatchewan soil climatic zones.

Regionally relevant information on seeding, field management and harvest exist in Saskatchewan for crops such as lentils, peas, soybeans, chickpeas, faba beans, and dry bean, but not for crops such as fenugreek, lupin, mung bean and cowpea data and general knowledge are lacking. This information would help to provide agricultural extension opportunities for farmers looking for increased crop diversification. With further improvements in cultural practices and cultivars, new and novel cropping options may be feasible for many regions in Saskatchewan. By demonstrating and introducing new and novel pulse crops to producers at field days and winter extension events, they are able see how these crops are, or are not, suited for the specific regions they are demonstrated in and determine whether adding these crops into their rotation is economically feasible. Growers and commodity groups are also looking for well-captured, high-resolution photograph of the novel pulse crops. Specifically, blue lupin, white lupin and fenugreek are of most interest.

https://saskpulse.com/resources/new-crop-feature-lupin/
https://saskpulse.com/growing-pulses/fenugreek/fenugreek-seeding/
https://saskpulse.com/resources/update-on-minor-new-novel-pulse-crops/
https://www.topcropmanager.com/exploring-the-possibility-of-mung-bean-production-4139/
https://saskpulse.com/resources/showcasing-the-production-of-new-novel-pulse-crops-in-saskatchewan/
https://www.researchgate.net/publication/267252534_Growth_and_dry_matter_yield_responses_of_cowpea_to_different_sowing_depths

Methodology

Field trials were initiated for the 2023 growing season at all 8 Saskatchewan Agri-ARM sites, including Swift Current (WCA), Indian Head (IHARF), Prince Albert (CLC), Outlook (ICDC), Melfort (NARF), Scott (WARC), Redvers (SERF) and Yorkton (ECRF). Running these demonstrations at multiple Agri-ARM sites provides provincial wide coverage across multiple soil zones and a wide range of growing conditions. Some crops are likely be better suited to certain regions, therefore having this information gives producers and opportunity to select crops and varieties best suited for their particular operation and environments. Treatments and varietal information are listed in Table 1.

Table 1. Crop, seed rate and variety information.

Crop	Variety	TKW (grams)	Distributor	Traits
Fenugreek 175 plants/m^2 250 plants/m^2	CDC Canafen	17.9	Emerald Seed Products Limited	White-flowered
White Lupin 40 seeds/m^2 56 seeds/m^2	Dieta	265	Lupin Platform Inc.	Purple/blue-flowered, shown resistance to Aphanomyces root rot
Blue Lupin& 40 seeds/m^2 56 seeds/m^2	Boregine	190	Lupin Platform Inc.	White-flowered, narrow- leaved, shown resistance to Aphanomyces root rot
Small Red Lentil 130 plants/m^2 190 plants/m^2	CDC Impulse	45	SeCan	Clearfield tolerant
Yellow Field pea 85 plants/m^2 95 plants/m^2	AAC Profit	226	FP Genetics	White-flowered, semi-leafless, medium seeded yellow pea

*Indian Head, Swift Current, Redvers, Scott and Prince Albert seeded blue lupin at 108 and 129 plants/m^2

Fenugreek and lupin, as well as a pulse reference crop (either peas, or lentils depending on the site location) were seeded at the current recommended (standard) seeding rate (based off previous research), as well as an increased rate. Each crop was replicated four times in a split block design to ensure a good visual representation and quality data. A pre-seed herbicide (glyphosate) was applied. In crop weed control using a combination of registered pre-seed and in-crop herbicides for grassy weeds including Centurion, or Poast Ultra and Assure II. For broadleaf weed control, Metribuzin is registered for in-crop applications for lupin. Odyssey is registered for fenugreek. Some hand weeding was permitted at the discretion of the site manager. Preventative fungicide applications were recommended to ensure that disease would not be a yield limiting factor. Although not all sites applied a fungicide, the risk of disease was low and it is highly unlikely that this had any impact on yields or the observed responses. Pre-harvest herbicides or desiccants were used at the discretion of individual site managers and, wherever possible, only the center rows of each plot were harvested to avoid potentially confounding edge effects. Where inoculants were limited, nitrogen fertilizer was applied according to a general soil test. Lupin platform supplied peat inoculant for lupins and was seed applied at a rate of 3 grams per kilogram of seed. Plot size varied across locations to accommodate the specific seeding and spraying equipment. Selected agronomic information and dates of operations are provided in Table 6 of the Appendices.

Various data were collected to evaluate the treatments and help explain the results:

1. A soil sample of the general area in order to note NPKS, as well as soil pH of and OM%.
2. Establishment (1 m row from front, middle and back of plot)
3. Weed Competition (1-5, 1=excellent weed control)
4. Yield (kg/ha)
5. Basic economics

Results

Soil Test Results and Growing Season Weather Conditions

Soil test results for all eight sites are provided in Table 2 below. Soil pH, organic matter, and C.E.C. values ranged widely but were all considered typical for their corresponding locations.

Table 2. Selected soil test analyses result at Indian Head (IH), Melfort (ME), Outlook (OL), Prince Albert (PA), Redvers (PA), Scott (SC), Swift Current (SW), and Yorkton (YK) in 2023. Unless otherwise indicated, all measurements are representative of the 0-15 cm soil profile.

Parameter	IH-23	ME-23	OL-23	PA-23	RV-23	SC-23	SW-23	YK-23
pH	7.8	6.2	7.7	5.9	7.9	5.7	6.7	6.8
Organic Matter (%)	5.5	8.7	2.7	5.7	3.4	3.8	2.9	7.8
CEC (meq)	45.6	37.0	15.3	18.4	33	14.7	16.7	27.4
NO_3-N (kg/ha) [Z]	16	41	24	57	29	21	19	55[Y]
Olsen-P (ppm)	7	16	8	4	6	17	8	16
K (ppm)	590	619	345	267	199	394	298	353
kg S/ha (kg/ha) [Z]	56	87	54	54	484+	105	49	77

Z=0-12"

Mean monthly temperatures for each location are presented along with the long-term (1981-2010) averages in Table 3 while precipitation amounts are in Table 4. All locations were considerably warmer than average, with May and June being particularly hot. July was slightly cooler than average to approximately average while August temperatures were approximately average to slightly above average. Over the four-month period from May through August, growing season temperatures ranged from 1.4-1.9 °C above average. Turning our attention to precipitation, all locations were much drier than average. Swift Current was the exception, with 95% of average precipitation. However, the soil moisture reserve has been very low since 2017. Unfortunately, the plots at Swift Current were also damaged by a hailstorm that resulted in an estimated 10-40% yield loss. Outlook was the driest of the sites with only 95 mm of precipitation (46% of average); however, this location is irrigated and received an additional 246 mm of irrigation water in June through August. The remaining locations received 49-70% of the long-term average precipitation amounts. Excluding Outlook, which was irrigated, Indian Head, Melfort, and Yorkton were the driest in both absolute terms and as a percentage of the long-term average.

Table 3. Mean monthly temperatures along with long-term (LT; 1981-2010) averages for the 2023 growing season at Indian Head (IH), Melfort (ME), Outlook (OL), Prince Albert (PA), Redvers (RV), Scott (SC), Swift Current (SW), and Yorkton (YK), Saskatchewan.

Year	May	June	July	August	May-Aug
	---------- Mean Temperature (°C) ----------				
IH-23	14.0	19.4	16.7	17.7	17.0 (+1.4)
IH-LT	10.8	15.8	18.2	17.4	15.6
ME-23	14.1	19.2	16.9	17.3	16.9 (+1.7)
ME-LT	10.7	15.9	17.5	16.8	15.2
OL-23	15.2	19.5	18.5	18.7	18.0 (+1.9)

OL-LT	11.5	16.1	18.9	18.0	16.1
PA-23	14.4	18.8	16.6	17.1	16.7 (+1.6)
PA-LT	10.4	15.3	18.0	16.7	15.1
RV-23	14.5	19.7	17.6	17.9	17.4 (+1.4)
RV-LT	11.1	16.2	18.7	18.0	16.0
SC-23	14.9	17.2	17.1	17.4	16.7 (+1.9)
SC-LT	10.8	14.8	17.3	16.3	14.8
SW-23	14.8	17.7	18.4	18.8	17.4 (1.6)
SW-LT	11.0	15.7	18.4	17.9	15.8
YK-23	13.8	19.7	16.7	17.8	17.0 (+1.8)
YK-LT	10.4	15.5	17.9	17.1	15.2

Table 4. Mean monthly precipitation amounts along with long-term (LT; 1981-2010) averages for the 2023 growing season at Indian Head (IH), Melfort (ME), Outlook (OL), Prince Albert (PA), Redvers (RV), Scott (SC), Swift Current (SW), and Yorkton (YK), Saskatchewan.

Year	May	June	July	August	May-Aug
	---------- Total Precipitation (mm) ----------				
IH-23	12.9	49.6	15.9	40.8	119 (49%)
IH-LT	51.8	77.4	63.8	51.2	244
ME-23	17.9	26.4	16.4	50.0	111 (49%)
ME-LT	42.9	54.3	76.7	52.4	226
OL-23	17.2	15.3 (117)	15.5 (86)	46.6 (43)	95 (46%)
OL-LT	42.6	63.9	56.1	42.8	205
PA-23	22.8	52.8	40.8	51.2	168 (67%)
PA-LT	44.7	68.6	76.6	61.6	252
RV-23	84.1	33.0	10.8	37.6	166 (62%)
RV-LT	60.0	95.2	65.5	46.6	267
SC-23	16.6	81.1	29.7	31.7	159 (70%)
SC-LT	38.9	69.7	69.4	48.7	227
SW-23	41.0	32.9	63.3*	42.1	179 (95%)
SW-LT	42.1	66.1	44.0	35.4	188
YK-23	16.8	67.9	18.0	33.3	136 (50%)
YK-LT	51.3	80.1	78.2	62.2	272

[Z] Values in parentheses Outlook are irrigation water

[Y] Hailstorm at Swift Current on July 22, 2023 resulted in an estimated 10-40% seed yield loss

Establishment and Yield

Plant densities were measured to provide insights into the overall establishment of each crop. A pulse reference crop (either peas, or lentils) was seeded at a standard recommended and increased seeding rate at each location. Yellow peas were seeded at Melfort, Outlook and Yorkton. While red lentils were seeded at Indian Head, Swift Current, Redvers, Scott and Prince Albert. It was common among all crops for increasing mortality at the increased seeding rate.

Peas and Lentils (Image 1).

Yellow peas were seeded at the recommended (85 plants/m^2) and increased rate (95 plants/m^2). Outlook resulted in a significantly different yellow pea population at the higher seeding rate (79 plants/m^2) compared to the standard seeding rate (73 plants/m^2, Table 7). Melfort yellow pea population was the lowest of the sites and did not significantly differ by seeding rate averaging 68 plants/m^2 Table 8). At Yorkton, yellow pea densities were intermediate and averaged 71 plants/m^2 at the recommended rate and 75 plants/m^2 at the increased seed rate (Table 9).

Yellow peas yielded very well at all 3 locations and well above the provincial 10-year average.[1] At Outlook (irrigation), yellow peas were the highest yielding crop and averaged 4,104 kg/ha. At Melfort, yellow peas seeded at the recommended rate was the highest yielding treatment overall (3,969 kg/ha) and significantly higher than peas seeded at the increased seed rate (3,475 kg/ha), even though plant densities did not significantly differ. This treatment yielded 64% higher than the next highest yielding crop, which was white lupin seeded at the recommended rate (2,419 kg/ha). The highest yielding site for yellow peas was Yorkton, where the increased seed rate resulted in a yield of 4,185 kg/ha, significantly different than the yield resulting from the recommended seed rate (3,691 kg/ha). This treatment was also a 46% yield increase over the next highest yielding crop, which was fenugreek seeded at the recommended rate (2,863 kg/ha).

All sites where lentils were seeded resulted in significantly higher plant populations as a result of the increased seed rate. Red lentils were seeded at a recommended (130 plants/m^2) and increased rate (190 plants/m^2). Average lentil populations in the order from highest to lowest site were Redvers (236 plants/m^2 Table 10), Swift Current (216 plants/m^2 Table 11), Indian Head (168 plants/m^2 Table 12), Prince Albert (140 plants/m^2 Table 13) and Scott (112 plants/m^2 Table 14).

Lentils were the highest yielding crop at Prince Albert and Scott. At Prince Albert, seeding rate had no effect on lentil yield and lentils yielded 43% higher (2,558 kg/ha) than the next highest yielding crop, which was fenugreek, seeded at the increased rate (1,787 kg/ha). At Scott, the highest yielding treatment resulted from the increased lentil seeding rate (3,577 kg/ha), significantly different than yield resulting from the recommended seed rate (3,402 kg/ha). This was 54% higher than the next highest yielding crop, which was fenugreek seeded at the increased rate (2,319 kg/ha). Seeding rate did not influence lentil yield at Prince Albert (2,509 kg/ha), Indian Head (2,435 kg/ha), or Swift Current (1,149 kg/ha). Redvers was the lowest yielding lentil site and the increased seed rate resulted in a significantly different yield (1,248 kg/ha) compared to the recommended rate (1,092 kg/ha).

[1] https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/market-and-trade-statistics/crops-statistics/crop-report#:~:text=Average%20yields%20in%20the%20province,rye%2036%20bushels%20per%20acre.

Image 1. Lentil plots seeded at 130 plants/m2 (left) and 190 seeds/m2 (right) at Swift Current on July 19, 2023.

White and Blue Lupin (Images 2-9).

White and Blue lupin seeding rate varied by location. Melfort, Outlook and Yorkton seeded both varieties at a recommended rate of 40 plants/m^2 and increased rate of 56 plants/m^2. However, Indian Head, Swift Current, Redvers, Scott and Prince Albert seeded white lupin at 65 and 86 plants/m^2 and blue lupin was seeded at 108 and 129 plants/m^2. There was an adjustment made to the blue lupin seeding rate in the protocol after some sites had initiated the trial. Recommended seeding rates for blue lupin is 40 plants/m^2 and the increased rate is 56 plants/m^2.

With the exception of Outlook, all sites observed increasing white lupin population with increasing seed rate. Scott had the lowest establishment rates for white lupin (53-54%), followed by Prince Albert (76-77%). With the exception of Redvers, all sites observed increasing blue lupin population with increasing seed rate. Percent establishment varied by location. At Indian Head, Swift Current, Melfort and Yorkton, blue lupin establishment rates were 100%. However, blue lupin percent establishment was less than 50% at Redvers and Scott.

White lupin yield from highest to lowest by site was Outlook (2,750 kg/ha), Melfort (2,419 kg/ha), Yorkton (2,355 kg/ha), Scott (2,270 kg/ha), Redvers (1,709 kg/ha), Indian Head (1,424 kg/ha), Swift Current (1,128 kg/ha) and Prince Albert (851 kg/ha). White Lupin seeded at the increased rate of 86 plants/m^2 was the highest yielding treatment at Redvers, and was 37% higher yielding than the red lentil reference crop (1,248 kg/ha). White lupin also yielded well at Swift Current (seeded the recommended rate and yielded 1,218 kg/ha), and was 2-4% higher yielding than the red lentil reference crop (1,172 kg/ha). At Melfort, Indian Head, Redvers, Scott, Swift Current and Yorkton white lupin yielded significantly higher than blue lupin. At both Melfort and Indian Head, white lupin yield did not significantly differ by seed rate (Melfort=2,409 kg/ha, Indian Head=1,373 kg/ha), and blue lupin yielded less when seeded at the higher rate (Melfort=997 kg/ha, Indian Head=773 kg/ha).

Blue lupin yields highest to lowest by site were Scott (2,170 kg/ha), Yorkton (1,522 kg/ha), Prince Albert (1,436 kg/ha), Melfort (1,187 kg/ha), Redvers (1,009 kg/ha), Indian Head (884 kg/ha), Swift Current (765 kg/ha) and Outlook (483 kg/ha). Blue lupin yields at Outlook were very low because of insect damage and poor nodulation. During a nodulation assessment, very few tiny nodules were observed. This could be due to the inoculant source being shipped between sites when the temperature was already above 25 degrees Celsius, possibly affecting viability. At Prince Albert, white lupin yielded significantly less (805 kg/ha) compared to blue (1,408 kg/ha). At Redvers, both varieties resulted in a significantly higher yield when seeded at the increased rate (white=1,709 kg/ha, blue=1,009 kg/ha).

Images 2-5. White lupin at emergence and flowering at various locations. Plots seeded at 65 plants/m^2 and 86 plants/m^2 at Swift Current (right).

Images 6-9. Blue lupin at emergence, flowering and pod. Plots seeded at 129 plants/m^2 and 108 plants/m^2 at Swift Current (right).

Fenugreek (Images 10-12).

Fenugreek was seeded at the recommended (175 plants/m^2) and increased rate (250 plants/m^2). Resulting plant stands were affected by seed rate in the expected manner at all sites. Percent establishment varied by location and was very poor at both Outlook (irrigation) and Scott ranging from 39-49%. Yorkton and Melfort were also poor with establishment ranging from about 56-66%. Indian Head and Prince Albert were intermediate in establishment ranging from 65-87%. Swift Current and Redvers resulted in at least 90% establishment.

The average fenugreek yield by location from highest to lowest was Yorkton (2,770 kg/ha), Indian Head (2,581 kg/ha), Scott (2,227 kg/ha), Prince Albert (1763 kg/ha). Redvers (1,428 kg/ha), Melfort (730 kg/ha), Swift Current (410 kg/ha) and Outlook (146 kg/ha). Although Yorkton was the highest yielding fenugreek site, the yellow pea reference crop seeded at the recommended rate was 28% higher yielding compared to fenugreek, and 56% higher yielding at the increased rate. At Indian Head, fenugreek yielded (2,572 kg/ha), similar to small red lentils (2,435 kg/ha).

Images 10-12. Fenugreek plots at Prince Albert (left and middle). Plots seeded at 175 plants/m^2 and 250 plants/m^2 at Swift Current (right).

Basic Economics

Table 5. Gross revenue ($/ac) per crop using average yields from 2023 at each Agri-ARM location and an estimated commodity price ($/lb). Crop inputs varied. White and blue lupin are assumed to be the same commodity price based on a 2023 white lupin contract. Fenugreek, peas and lentil commodity price is taken from the 2024 Saskatchewan Ministry of Agriculture Crop Planning Guide.

Crop	Variety	Estimated Commodity price ($/lb)	Indian Head	Melfort	Outlook	Prince Albert	Redvers	Scott	Swift Current	Yorkton
Fenugreek	CDC Canafen	0.30[Z]	690	194	39	471	380	595	110	740
White Lupin	Dieta	0.26[Y]	318	558	578	186	369	520	273	527
Blue Lupin	Boregine	0.26[Y]	192	253	96	326	215	469	173	330
Small Red Lentil	CDC Impulse	0.30[Z]	650	-	-	670	312	932	307	-
Yellow Field Pea	AAC Profit	0.18[Z]	-	596	658	-	-	-	-	631

Z https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/farm-business-management/crop-planning-guide-and-crop-planner

Y chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.soya-uk.com/wp-content/uploads/2022/10/White-Lupin-Contracts-2023.pdf

Pest Management

Weed Control (Scale of 1-5, 1=complete control)

Weeds were not a limiting factor in this trial. Seeding peas resulted in good weed control at all sites; Yorkton (1), Outlook (1) and Melfort (2) and weed control was not affected by seed rate. Lentils also resulted in good weed control at Swift Current (1), Prince Albert (2) and Redvers (2) and was not affected by seed rate. Lentils resulted in good weed control at Scott (2) and control increased with increasing seeding rate. At Outlook, Redvers and Prince Albert fenugreek and lupins had the poorest weed control. Indian Head did not use any in-crop herbicides, but rather hand weeded.

Though grassy weeds were well controlled, broadleaf weeds were sometimes a challenge. At Swift Current, herbicide injury was observed in white lupin plots a few days after an in-crop application of Metribuzin (Images 13-15). It was noted that white lupins appeared to be more sensitive to Metribuzin compared to blue lupins. However, symptoms disappeared by two weeks post application and were not thought to have largely affected yield, or quality.

Images 13-15. White lupin plants 5 days after in-crop application of Metribuzin at 111g/ac (June 14, 2023) at Swift Current.

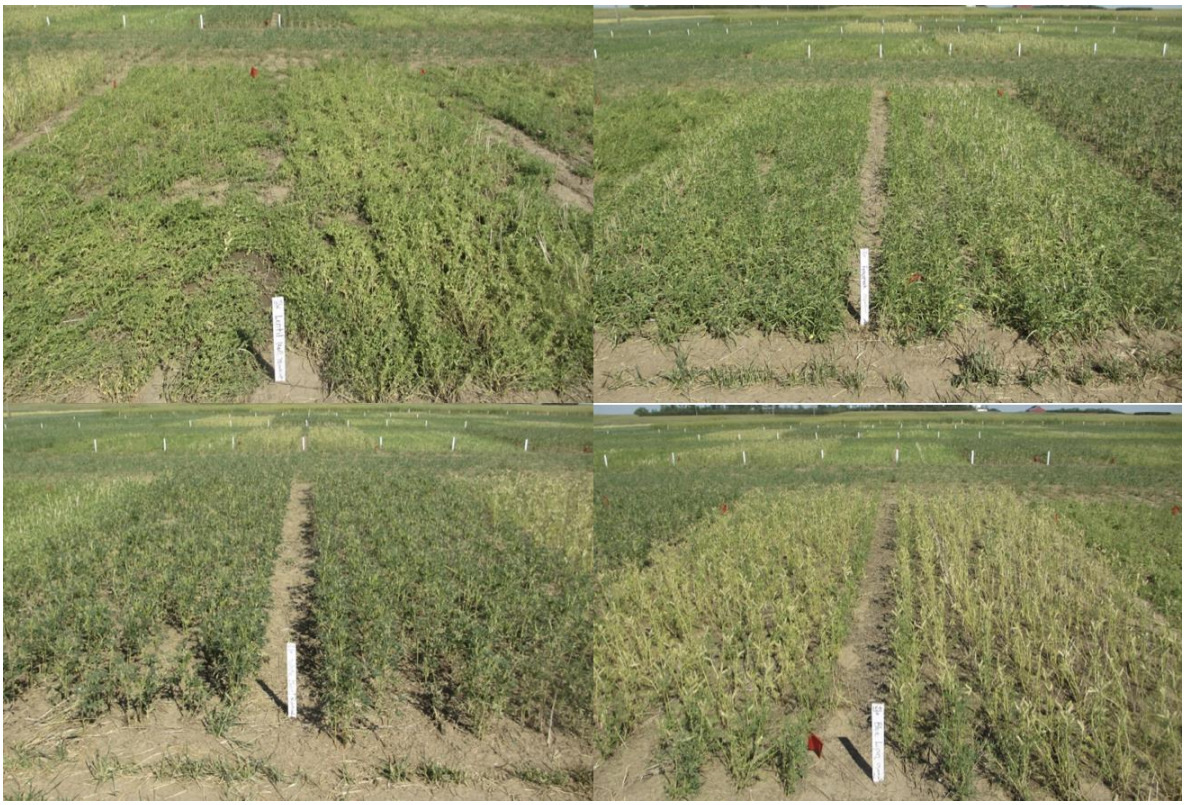
Insect Control

Blister beetles are preferential feeders on lupin species and caused damage at several sites (Images 16-18) to both leaves and stems. No economic threshold for blister beetles in lupins has been determined. However, an early insecticide application (Decis, or Matador) was recommended. Grasshopper damage was also evident at Outlook and Melfort. The economic threshold in field for spraying special crops for grasshoppers is 13/m^2. Grasshoppers were a persistent threat on the whole site at Indian Head; however, foliar insecticides were applied on three separate occasions and no preferential feeding on any of the pulse crops evaluated was noted.

Images 16-18. Blister beetles feeding on white lupin (left and middle) and grasshopper damage to blue lupin (right) at Outlook.

Hailstorm

The Swift Current site received hail on July 22, 2023. Yield loss for each crop was estimated (Images 19-22). Fenugreek and lentils resulted the least damage at 10% and 20%, respectively. Both blue and white lupin were estimated to have 35-40% yield loss. No visual differences in yield loss were noted between seed rates.



Images 19-22. Lentil (top left), fenugreek (top right), white lupin (bottom left) and blue lupin (bottom right) plots after the hailstorm on July 22, 2023 at Swift Current.

Extension Activities (Images 23-25).

At Swift Current, this project was highlighted by Michael Brown during the 2023 Annual Wheatland Conservation Area Field Day, held on July 18th (80 participants). Meagen Reed also showed the trials during the Scott Field Day on July 12th (120 participants), as well as at Outlook Field day July 13th. Lana Shaw toured the Redvers trial during the SERF Field Day on July 27th (50 participants). Mike Hall acknowledged the trial during then ECRF farm tour on July 20th (80 participants). Meagen Reed also presented this field trial in Prince Albert at the Annual Field Day, held July 27th (70 participants) and Melfort field day on July 26th (70 participants). Robin Lokken shared preliminary results at an Organic Producer meeting, held in February of 2024 (19 participants). The trial was featured by Amber Wall on a weekly radio show, "Walk the Plots" that airs in Southwest Saskatchewan throughout the summer. This final project report will also be available online at www.wheatlandconservation.ca as well as featured in various articles through the Saskatchewan Pulse Growers.

Conclusions and Recommendations

The objective of this demonstration was to provide producers with basic economic and agronomic information and help to provide agricultural extension delivery to farmers for increased crop productivity. With further improvements in cultural practice and cultivars, new and novel crop production may be feasible for regions in Saskatchewan.

Weed control was not a limiting factor for these crops. Peas and lentils generally had the best weed control, likely due good emergence and canopy closure. Fenugreek is also quite competitive provided that emergence is adequate, as fenugreek also has good weed control options. Herbicide injury was noted from an in-crop Metribuzin application to white lupin. However, as symptoms disappeared it was not thought to have caused any yield loss. There was moderate to high blister beetle and grasshopper pressure and an early insecticide application is recommended.

Pea density increased with seed rate at 2 of the 3 locations and at sites where peas were seeded, no crop out yielded the yellow pea pulse reference crop. Seed rate effect on yield varied by site. Lentil population generally increased with seed rate and also had a varied effect on yield. Lentil reference crops were the highest yielding treatments at Prince Albert (no seed rate effect) and Scott (increased seed rate resulted in significantly higher yield). Swift Current lentil yields were not affected by seed rate and did not result in a significantly different yield than white lupin seeded at the recommended rate. White lupin, as well as fenugreek seeded at the increased rate, out yielded the lentil reference crop at Redvers. White and blue lupin plant populations both increased with seed rate. Fenugreek plant population increased with seed rate and percent establishment varied by site. At Indian Head, fenugreek seeded at the recommended rate yielded similar to the lentil reference crop. Lentil seed rate at Indian Head had no effect on lentil yield.

Having marketing opportunities for these crops is still a challenge. However basic economic information is provided and shows a gross revenue per crop at each location. Crop diversity cannot be understated, as we need to mitigate root rots in peas and lentils through new and diversified pulse crop acres. It is already known that it is important to have pulses in your rotations for diversity, but diversity within your pulse crops themselves helps break up cycles of disease, pest, and weed cycles. Adapting new crops to each growing region and processing infrastructure is just a small portion of ongoing efforts in the pulse industry.

Sustainable Canadian Agricultural Partnership (Sustainable CAP) Performance Indicators

a) List of performance indicators

Sustainable CAP Indicator	Total Number
Scientific publications from this project (List the publications under section b)	
• Published	0
• Accepted for publication	0
HQPs trained during this project	
• Master's students	0
• PhD students	0
• Post docs	0
Knowledge transfer products developed based on this project (presentations, brochures, factsheets, flyers, guides, extension articles, podcasts, videos). List the knowledge transfer products under section (c)	10

[1] Please only include the number of unique knowledge transfer products.

b) List of scientific journal articles published/accepted for publication from this project.

Title	Author(s)	Journal	Date Published or Accepted for Publication	Link (if available)
n/a	n/a	n/a	n/a	n/a

c) List of knowledge transfer products/activities developed from this project.

Knowledge Transfer Product or Activity	Event/Location Where Knowledge Transfer Was Conducted	Estimated # of Producers Participated In Knowledge Transfer
Michael Brown (SPG) plot tour	WCA Field Tour (July 18, 2023)	80
Amber Wall (WCA) radio show	Walk the Plots radio show on 570 CKSW	Southwest Saskatchewan
Lana Shaw (SERF) plot Tour	SERF Field Tour (July 27, 2023)	50
Meagen Reed (SPG) plot tour	WARC Field Tour (July 12, 2023)	100

Meagen Reed (SPG) plot tour	ICDC Field Tour (July 13, 2023)	220
Mike Hall (ECRF) plot Tour	ECRF Field Day (July 20, 2023)	80
Meagen Reed (SPG) plot tour	NARF Field Tour (July 26, 2023)	70
Meagen Reed (SPG) plot tour	CLC Field Tour (July 27, 2023)	70
Robin Lokken (CLC) presentation	Organic Producer Meeting, Prince Albert (February 22, 2024)	19
Full Report	WCA Website	n/a

Acknowledgements

Funded in part by the Government of Canada under the Sustainable Canadian Agricultural Partnership, a federal-provincial-territorial initiative.

- Shannon Chant, Crops Extension Specialist, Saskatchewan Ministry of Agriculture

Seventy-two percent (72%) of costs associated with consultant and contractual services, as well as cost for data analyses and report preparation provided by the Saskatchewan Pulse Growers.

- Meagen Reed, Agronomy Manager, Saskatchewan Pulse Growers.
- Michael Brown, Agronomy Manager, Saskatchewan Pulse Growers.

Lupin seed and inoculant was provided in-kind by AgCall and Lupin Platform Inc. (LPI).

- Mark Olson, Research Agrologist, Lupin Platform Inc.

We would also like to acknowledge the Board of Directors from each of the participating organizations in addition to the many technical and professional staff, without whom this project could not have been completed. IHARF, NARF, WARC, and WCA also have strong working relationships and memorandums of understanding with Agriculture and Agri-Food Canada which should also be acknowledged.

Appendices

Expenditure Statement

The expenditure statement was submitted in a separate document and is available upon request.

Table 6. Selected agronomic information and dates of operations at Indian Head, Melfort, Outlook, Prince Albert, Redvers, Scott, Swift Current, and Yorkton, Saskatchewan.

Activity	Indian Head	Melfort	Outlook	Prince Albert	Redvers	Scott	Swift Current	Yorkton
Previous Crop	Wheat	Wheat	Wheat	Oat	Wheat	Wheat	Wheat	Wheat
Pre-Emergent Herbicide	May-20 (glyphosate)	May-19 (StartUp)	-	May-12 (glyphosate)	Jun-2 (glyphosate)	May-08 (glyphosate)	Apr-28 (glyphosate)	-
Seeding Date	15-May	18-May	17-May	18-May	01-Jun	12-May	17-May	19-May
Row Spacing (inches)	12	12	10	10	12	10	8.25	31 cm
Seed Depth (inches)	0.75 (lentil and fenugreek) 1.25 (lupin)	1	1	1-1.5	1-1.25	0.75	1-1.25	1-1.5
kg N-P_2O_5-K_2O-S/ha [z]	25-35-17-17	0-56-0-17	0-20-0-0	56-17-0-0	50-15-0-0	26-39-19-19	50-15-0-0	50-15-0-0
Inoculated	peat	peat	peat	peat	peat	peat	peat	peat
Plots Rolled	17-May	-	-	-	-	15-May	18-May	-
Emergence Counts	12-Jun	07-Jun	05-Jun	19-Jun	20-Jun	16-Jun	06-Jun	05-Jun
Weed Rating	Hand weeded	15-Jun	-	28-Jun	08-Aug	12-Jun	04-Jul	-
In-crop Herbicide Lentils	-	-	Jun-23 (clethodim)	-	-	Jun-5 (Solo Ultra Q)	-	-
In-crop Herbicide Lentils and Fenugreek	Jun-7 (Odyssey NXT)	-	-	-	-	-	Jun-7 (Odyssey NXT)	-
In-crop Herbicide all	Jun-6 (Casiva Ultra Q)	Jun-2 Centurion	-	-	Jun-23 Centurion	Jun-7 (Poast)	Jun-09 (Sencor75 DF)	-
Insecticide	Jun-16 (Decis)	-	May-30 (Matador)	Jun-20 (Decis)	-	Jun-13 (Decis)	Jun-12 (Decis)	-
Insecticide	Jun-22 (Coragen Max)	-	Jun-12 (Matador)	-	-	Jul-07 (Decis)	Jul-01 (Decis)	-
Insecticide	Jul-21 (Coragen Max)	-	Jun-29 (Matador)	-	-	-	-	-
Fungicide Date	Jun-27 (Dyax)	-	-	-	-	-	-	-
Fungicide Date	Jul-7 (Dyax)	-	-	-	-	-	-	-
Harvest Dates	18-Aug	Aug-14 (peas), Sep7- (blue lupins), Sept-11 (fenugreek), Oct-10 (white lupins)	Aug-18 (peas), Aug-18 (blue lupins), Oct-10 (fenugreek), Oct-10 (white lupins)	Aug-17 (lentils), Aug-25 (blue lupins), Sept-15 (fenugreek), Oct-11 (white lupins)	Sept-08 (blue lupin), Sept-20 (fenugreek), Oct-11 (lentil and white lupin).	Aug-08 (lentils), Aug-08 (blue lupins), Sept-12 (fenugreek), Sept-12 (white lupins)	Aug-17 (lentils, (blue lupins), Sept-11 (fenugreek), Sept-19 (white lupins)	Aug-25 (peas), Sept-26 (blue lupins, fenugreek), Oct-07 (white lupins)

Table 7. Individual Means for plant density and yield (kg/ha) at Outlook, 2023.

ICDC	Plant Density plants/m^2		Weed Control 1-5, 1=best		Yield kg/ha	
Grand Mean	61		3		1791	
CV	14.6				19.6	
Crop						
Yellow pea	76	b	1		4104	a
White lupin	36	c	3		2498	b
Blue lupin	40	c	2		415	c
Fenugreek	92	a	5		146	d
LSD	8				495	
Seed rate						
Standard	58	a	3		1667	a
Increased	64	a	3		1914	a
LSD	11				701	
Crop x Seed rate						
Yellow Pea - standard	73	d	1		4179	a
Yellow Pea - increased	79	c	1		4029	a
White Lupin - standard	35	f	3		2010	c
White Lupin - increased	37	f	3		2988	b
Blue Lupin - standard	35	f	2		346	de
Blue Lupin - increased	44	e	2		483	d
Fenugreek - standard	87	b	5		134	e
Fenugreek - increased	98	a	5		157	e
LSD	4				248	

Table 8. Individual Means for plant density and yield (kg/ha) at Melfort, 2023.

NARF	Plant Density plants/m2		Weed Control 1-5, 1=best		Yield kg/ha	
Grand Mean	68		3		1988	
CV	13				19	
Crop						
Yellow pea	67	b	2		3722	a
White lupin	37	c	3		2409	b
Blue lupin	44	c	3		1092	c
Fenugreek	125	a	3		730	d
LSD	7				319	
Seed rate						
Standard	60	b	3		2032	a
Increased	77	a	3		1944	a
LSD	10				451	
Crop x Seed rate						
Yellow Pea - standard	68	c	2		3969	a
Yellow Pea - increased	67	c	2		3475	b
White Lupin - standard	29	g	3		2419	c
White Lupin - increased	45	e	3		2399	c
Blue Lupin - standard	37	f	3		1187	d
Blue Lupin - increased	51	d	3		997	e
Fenugreek - standard	105	b	4		745	f
Fenugreek - increased	144	a	3		715	f
LSD	4				159	

Table 9. Individual Means for plant density and yield (kg/ha) at Yorkton, 2023.

ECRF	Plant Density plants/m²		Weed Control 1-5, 1=best	Yield kg/ha	
Grand Mean	76		4	2579	
CV	22			17	
Crop					
Yellow pea	73	b	1	3938	a
White lupin	49	c	3	2276	c
Blue lupin	52	bc	4	1424	d
Fenugreek	132	a	2	2770	b
LSD	14			375	
Seed rate					
Standard	65	b	2	2519	a
Increased	88	a	3	2685	a
LSD	20			531	
Crop x Seed rate					
Yellow Pea - standard	71	c	1	3691	b
Yellow Pea - increased	75	c	1	4185	a
White Lupin - standard	43	e	3	2197	d
White Lupin - increased	55	d	3	2355	d
Blue Lupin - standard	46	e	4	1326	f
Blue Lupin - increased	58	d	4	1522	e
Fenugreek - standard	98	b	2	2863	c
Fenugreek - increased	166	a	2	2677	c
LSD	7			188	

Table 10. Individual Means for plant density and yield (kg/ha) at Redvers, 2023.

SERF	Plant Density plants/m²	Weed Control 1-5, 1=best	Yield kg/ha	
Grand Mean	138	2	1280	
CV	29		2	
Crop				
Red lentil	236	2	1170	b
White lupin	74	2	1593	a
Blue lupin	54	3	930	c
Fenugreek	191	3	1428	a
LSD	34		210	
Seed rate				
Standard	124	3	1183	a
Increased	153	2	1377	a
LSD	48		298	
Crop x Seed rate				
Red Lentil - standard	221	2	1092	d
Red Lentil - increased	250	2	1248	c
White Lupin - standard	65	2	1477	b
White Lupin - increased	83	1	1709	a
Blue Lupin - standard	48	3	851	e
Blue Lupin - increased	59	3	1009	d
Fenugreek - standard	161	3	1313	c
Fenugreek - increased	220	2	1542	b
LSD	17		105	

Table 11. Individual Means for plant density and yield (kg/ha) at Swift Current, 2023.

WCA	Plant Density plants/m²		Weed Control 1-5, 1=best	Yield kg/ha	
Grand Mean	172		1	871	
CV	14			17	
Crop					
Yellow pea	216	a	1	1149	a
White Lupin	124	b	1	1181	a
Blue Lupin	143	b	1	745	b
Fenugreek	206	a	1	410	c
LSD	20			131	
Seed rate					
Standard	150	b	1	887	a
Increased	195	a	1	856	a
LSD	10			185	
Crop x Seed rate					
Red Lentil - standard	181	c	1	1172	ab
Red Lentil - increased	251	a	1	1126	b
White Lupin - standard	109	f	2	1218	a
White Lupin - increased	139	de	1	1144	b
Blue Lupin - standard	137	e	1	726	c
Blue Lupin - increased	149	d	1	765	c
Fenugreek - standard	172	c	1	432	d
Fenugreek - increased	240	b	1	389	d
LSD	10			65	

Table 12. Individual Means for plant density and yield (kg/ha) at Indian Head, 2023.

IHARF	Plant Density plants/m²		Yield kg/ha	
Grand Mean	138		1753	
CV	15		7	
Crop				
Red lentil	168	a	2435	b
White lupin	101	c	1373	c
Blue lupin	124	b	828	d
Fenugreek	161	a	2581	a
LSD	18		107	
Seed rate				
Standard	109	b	1802	a
Increased	167	a	1807	a
LSD	26		151	
Crop x Seed rate				
Red Lentil - standard	132	c	2430	b
Red Lentil - increased	203	a	2441	b
White Lupin - standard	88	f	1323	d
White Lupin - increased	114	d	1424	c
Blue Lupin - standard	104	e	884	e
Blue Lupin - increased	144	b	773	f
Fenugreek - standard	113	d	2572	a
Fenugreek - increased	208	a	2590	a
LSD	9		54	

Table 13. Individual Means for plant density and yield (kg/ha) at Prince Albert, 2023.

CLC	Plant Density plants/m2		Weed Control 1-5, 1=best		Yield kg/ha	
Grand Mean	116		3		1621	
CV	14				18	
Crop						
Red lentil	140	b	2		2509	a
White lupin	58	d	2		805	d
Blue lupin	104	c	2		1408	c
Fenugreek	161	a	3		1763	b
LSD	14				246	
Seed rate						
Standard	104	b	3		1608	a
Increased	127	a	2		1635	a
LSD	20				348	
Crop x Seed rate						
Red Lentil - standard	122	c	2		2460	a
Red Lentil - increased	157	b	2		2558	a
White Lupin - standard	49	f	3		851	d
White Lupin - increased	66	e	2		759	d
Blue Lupin - standard	93	d	2		1380	c
Blue Lupin - increased	115	c	2		1436	c
Fenugreek - standard	153	b	3		1739	b
Fenugreek - increased	170	a	3		1787	b
LSD	7				123	

Table 14. Individual Means for plant density and yield (kg/ha) at Scott, 2023.

WARC	Plant Density plants/m2		Weed Control 1-5, 1=best		Yield kg/ha	
Grand Mean	74		2		2497	
CV	17				7	
Crop						
Red lentil	112	a	2		3489	a
White lupin	40	d	1		2246	b
Blue lupin	52	c	2		2026	c
Fenugreek	93	b	3		2227	b
LSD	11		1		148	
Seed rate						
Standard	66	b	2		2424	a
Increased	83	a	2		2571	a
LSD	15				210	
Crop x Seed rate						
Red Lentil - standard	101	b	3		3402	b
Red Lentil - increased	123	a	2		3577	a
White Lupin - standard	35	f	1		2270	cd
White Lupin - increased	46	e	2		2222	de
Blue Lupin - standard	41	e	2		1888	g
Blue Lupin - increased	63	d	2		2164	ef
Fenugreek - standard	86	c	4		2135	f
Fenugreek - increased	100	b	3		2319	c
LSD	5				74	

Image 23. Meagen Reed, SPG presenting trial at ICDC field tour (July 13 2023) at Outlook, SK.


Image 24. Mike Brown, SPG presenting trial at WCA field tour (July 18, 2023) at Swift Current, SK.

Image 25. CLC plot tour (July 27, 2023) at Prince Albert, SK.