MANITOBA Pulse Soybean GROWERS

pulse beat

The Science Edition

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In this issue

Yield & Quality ‣ Pest Control ‣ Soil Health ‣ Market Demand

Developing production tools and market demand for profitable and sustainable farms through local research.

PM40016070

Many in the agri-food industry tell farmers how to be 'sustainable,' often with reference to their own products and services.

For farmers, sustainability will emerge from a complex set of moving parts. Pulses and soybeans are a part of this complexity, both in ways we understand and in ways we're still investigating.

This path to sustainability starts with optimizing the individual parts of annual legume production and continues by synchronizing those parts into a profit-generating system across all crops. For example, to reduce narrow-row dry bean herbicide expenses, farmers may want to consider precise camera-guided inter-row cultivation – a practice enhanced through synchronization with varied row spacing and plant densities. While this is easier said than done, MPSG's research program supports farmers through this optimization and synchronization process. MPSG funds research that examines each moving part in isolation and then tests synchronization by studying the interactions among those parts.

This issue of the *Science Edition* mostly conveys results from studies of individual moving parts. Soybean cyst nematode (SCN) is a moving part globally. In Manitoba, we have a lot to learn about SCN, first by finding them and then by examining their genes. Other moving soybean parts include potassium nutrition and the decision of whether or not to roll. Variety selection is also a moving part considered through MPSG's variety testing program. Farmers wanting more moving parts might consider growing azuki beans. Customer demand for health and functional benefits from our pulse and soybean crops is yet another moving part that MPSG is tackling through research to create new opportunities in high-value markets.

The pressure is on farmers to demonstrate sustainability. To increase the chances you will benefit, MPSG will continue to optimize and synchronize crop production practices on your behalf.

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Pulse and Soybean Regional Variety Testing

For nearly 30 years, pulse and soybean varieties have been evaluated across Manitoba to provide independent variety performance information to farmers. The success of this program is a product of the long-standing team effort across groups and provinces.

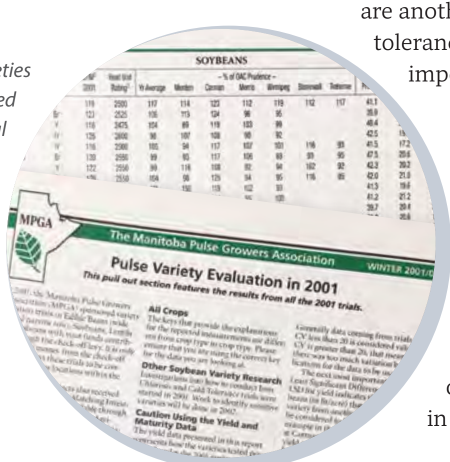
Photo by Kevin Baron, Solum Valley Biosciences Inc.

MANITOBA PULSE & SOYBEAN GROWERS (MPSG) has been involved in variety testing of pulse and soybean crops for nearly 30 years. Each year, the independent evaluation of soybean, dry bean, field pea, faba bean and lentil varieties is carried out at several locations across Manitoba.

The goal of this program is to provide farmers with independent information on variety performance and agronomic characteristics to make informed variety selection decisions.

Soybean and dry bean trials are currently sponsored, administered and conducted by MPSG. Field pea, faba bean and lentil trials are coordinated with the Saskatchewan Regional Variety Testing Program, conducted by the Manitoba Crop Variety Evaluation Team (MCVET) and co-sponsored by MPSG, MCVET and Manitoba Agriculture and Resource Development (MARD).

Each year, seed companies submit varieties for evaluation and independent contractors carry out the small plot trials, including everything from planting to harvest. All trials have three replicates and randomization of varieties to enable statistical analysis. Varieties are also compared to a check variety for each crop type or region to account for differences in conditions across sites and years. To ensure high-quality data, rigorous analysis and review is carried out by MCVET and MPSG. Plots or trial locations that do not meet specific standards are rejected.



Soybean varieties were first tested in the regional variety trials in 2001.

Interestingly, some varieties have remained constant over the years, showcasing the longevity of this program. As of 2020, the conventional soybean variety, OAC Prudence, clocked in at 136 site-years tested, the pea variety, CDC Meadow, reached 85 site-years and the pinto bean variety, Windbreaker, reached 56 site-years.

Standard measurements for all trials include yield and days to maturity. Measurements of other agronomic characteristics differ by site and by crop. For example, iron deficiency chlorosis (IDC) ratings are conducted at a location near Winnipeg that is prone to IDC to enhance symptoms of the condition and reveal the tolerance expressed by each soybean variety. Common bacterial blight and white mould ratings in dry bean trials are another example to determine the tolerance of bean varieties to these two important diseases.

Where to find this wonderful compilation of information? In the MPSG *Pulse and Soybean Variety Guide*, which is mailed to our farmer membership each year, in *Seed Manitoba* or online at manitobapulse.ca and seedmb.ca.

This variety testing program offers more than what you see in the guides. With the growing importance of protein as a quality indicator, you can find crude protein levels for soybean and field pea varieties at the aforementioned websites.

This program has also become a gateway for additional Manitoba-based research. Soybean protein measurements are now part of a more extensive study looking at critical amino acid values of varieties grown in Manitoba, along with their feeding value for poultry and swine. Another project has utilized high-resolution imaging to assess physical (phenotypic) differences among varieties and predict critical growth stages for soybeans in Manitoba. And a brand-new project will be looking at phenotyping and high-throughput techniques (that make large-scale repetition feasible) to closely monitor and report genetic differences in crop growth and development.

It is clear that the success of these trials is a product of the long-standing team effort across groups and provinces. The regional variety testing program is set to continue for pulses and soybeans, with the assistance of MARD, AAFC, diversification centres (WADO, PCDF, PESAI, CMCDC) and the private research companies that play an integral role.

PRINCIPAL INVESTIGATORS Manitoba Pulse & Soybean Growers (soybeans, dry beans), Manitoba Crop Variety Evaluation Team (peas, faba beans, lentils) | MPSG 2020 INVESTMENT $138,420 (soybeans), $41,390 (dry beans), $7,000 (peas, faba beans, lentils)

CO-FUNDERS Manitoba Crop Variety Evaluation Team, Manitoba Agriculture and Resource Development

DURATION 28 years – ongoing

Azuki Beans – An Alternative Pulse Crop in Manitoba

Ten azuki bean lines were identified with good adaptation to Manitoba growing conditions. All lines had lower yield and longer maturity than the navy bean checks, but greater resistance to common bacterial blight and bacterial brown spot. Four of the ten lines had promising yield levels.

AZUKI BEANS ARE an important pulse crop worldwide, especially in China, Japan and Korea. In recent years, production has significantly increased in Ontario, but no production has been reported in Manitoba or other western Canadian provinces.

Research and development of azuki beans in North America is very limited and there are currently no varieties available that are adapted to Manitoba growing conditions. The objective of this study was to investigate the feasibility of growing azuki beans in southern Manitoba.

From a larger collection of azuki lines sourced from the USDA and China, 24 lines were selected and grown in small plot trials at Morden and Winkler in 2017. In 2018 and 2019, 20 to 22 of these lines were grown again at Morden, Portage and Winkler. All azuki beans were compared to the navy bean check varieties, T9905 and Envoy. Agronomic characteristics were measured, including yield, days to maturity (DTM), thousand seed weight (TSW) and plant height. Resistance to common bacterial blight (CBB) and bacterial brown spot (BBS) were also evaluated in the dry bean disease nursery at Morden.

Dry soil conditions during seeding in 2018 and 2019 resulted in low and uneven emergence. The weed pressure experienced in these plots also showed the poor competitive ability of azuki beans compared to other bean types.

In general, azuki bean yields were significantly lower than the navy bean checks. Average azuki yields ranged from 1243–1624 lbs/ac in 2017 and 280–690 lbs/ac in 2018 (Table 1). Yields were much more variable in 2019 due to poor emergence and snow-covered plots at harvest, ranging from 21–1367 lbs/ac (data not shown). The most comparable azuki lines relative to the navy bean checks were MAZ-3303, MAZ-3320, MAZ-3323 and MAZ-3311 (Table 1). It should be noted that there is a price premium for azuki beans, which may offset lower yields.

All azuki lines matured significantly later than the navy bean checks. Days to maturity (DTM) for azuki beans was 104 to 112 days, compared to 89 to 92 days for navy beans (Table 1). This finding suggests that earlier planting would be more suitable for this alternative bean type, but it comes with the risk of spring frost in Manitoba. Leaves of azuki plants also remained green much longer after pods had matured than the navy bean checks, highlighting the benefit of desiccation.

As for other agronomic characteristics, azuki bean plants were comparable in height to Envoy navy beans, but all lines were significantly shorter than T9905 (Table 1). Seed weights of all azuki lines, except MAZ-3303, were lower than the navy bean check varieties (Table 1).

Assessments of CBB (2018) and BBS (2019) proved that azuki beans had greater resistance than the check variety, Envoy (Table 1), and similar or better resistance ratings than the CBB-resistant checks, HR45 and OAC Rex (data not shown). This finding is promising for farms that deal with high CBB or BBS infections.

Testing the best azuki bean lines will continue at Morden to provide additional evaluations. Future directions from this research would be to assess weed control and proper herbicide selection, as azuki beans are sensitive to injury from common dry bean herbicides.

Table 1. Agronomic performance and disease resistance of the top azuki bean lines compared to navy beans.

Azuki Bean Lines	2017 Yield (lbs/ac)	2018 Yield (lbs/ac)	Days to Maturity (DTM)	TSW (g/1000 seeds)	Plant Height (cm)	CBB Severity (1–5)	CBB Incidence (%)	BBS Severity (1–5)	BBS Incidence (%)
MAZ-3317	1243	431	104	110	39	0	0	3	7
MAZ-3340	1254	448	108	120	39	3	2	3	5
MAZ-3320	1576	690	109	117	40	0	0	3	3
MAZ-3323	1546	507	111	119	43	0	0	3	4
MAZ-3345	1393	280	111	121	38	1	0	3	6
MAZ-3303	1624	680	112	141	45	0	0	3	7
MAZ-3335	1553	348	112	113	40	1	0	2	5
MAZ-3311	1527	492	112	112	47	0	0	3	4
MAZ-3338	1373	383	112	108	41	1	0	3	5
MAZ-3304	1284	473	112	116	48	0	0	3	4
Navy Bean Check Varieties									
Envoy	1974	1971	89	159	41	5	77	3	37
T9905	–	2502	92	161	54	–	–	–	–
CV %	18.7	36	3.8	8.5	6.5	11.2	45.1	4.3	62
LSD (0.05)	342	411	4	21	5	1	2	1	7

CV = coefficient of variation; LSD = least significant difference at a 95% confidence level. Bacterial brown spot (BBS) results are from 2019. Common bacterial blight (CBB) results are from 2018. Severities were rated on a 0 to 5 scale, where 0 = no symptoms, 1 = <5%, 2 = 5–10%, 3 = 10–25%, 4 = 25–50% and 5 = 50–100%.

PRINCIPAL INVESTIGATOR Dr. Anfu Hou, Agriculture and Agri-Food Canada – Morden

MPSG INVESTMENT $108,000

DURATION 3 years

Soybean Response to Potassium Fertilization in Manitoba

The standard 100 ppm soil test K threshold is unreliable for predicting soybean yield response to K fertilization in Manitoba. Where soil test K values are less than 100 ppm, K fertility can be maintained by applying fertilizer at rates to match expected soybean removal.

SOYBEANS REMOVE POTASSIUM (K) at a much greater rate than most other crops grown in Manitoba. Large amounts of K removal (1.1–1.4 lbs K_2O/bu) coupled with expanded production has led to an increased occurrence of K deficiency symptoms in soybeans. This has raised questions about proper K fertility when soybeans are grown in rotation, especially in sandy Manitoba soils that may be inherently low in K.

The objectives of this research were to:

1. investigate the frequency of soybean yield response to K fertilization across a range of soil test K (STK) concentrations
2. determine the effectiveness of different K fertilizer rate and placement combinations to improve soybean yield.

Field scale trials in cooperation with MPSG's On-Farm Network were used to investigate the frequency of soybean yield response to 60 lbs K_2O/ac banded away from the seed or 120 lbs K_2O/ac broadcast and incorporated prior to planting. STK ranged from 49–451 ppm to investigate responsiveness on both sides of the standard 100 ppm ammonium acetate STK threshold listed in the *Manitoba Soil Fertility Guide* (Table 1).

Small plot trials were established to test K fertilizer rate and placement combinations, including 30 or 60 lbs K_2O/ac side-banded at planting, and 30, 60 or 120 lbs K_2O/ac broadcast and incorporated prior to planting. These trials were conducted on low K soils (49–117 ppm ammonium acetate STK) to increase the likelihood of response. In the second year of the study, an additional small plot trial was conducted on low K soils to investigate the K responsiveness of soybeans compared to barley, which is known to respond to K fertilization in Manitoba.

In the field scale on-farm trials, soybean yield generally did not respond to K fertilization. Only two out of 19 site-years had significant yield increases, but there were no differences in mid-season tissue K concentrations and only one of these two responsive sites had background STK below 100 ppm.

There were no significant yield differences between K fertilizer treatments for any of the seven small plot site-years. This was surprising, given that the soils at these sites were low in K. In the barley-soybean K responsiveness comparison, K fertilization did not influence soybean yield. However, barley yield significantly increased by about 20% across the three sites (Figure 1). This indicates that soybeans appeared to use K reserves in the soil that barley did not.

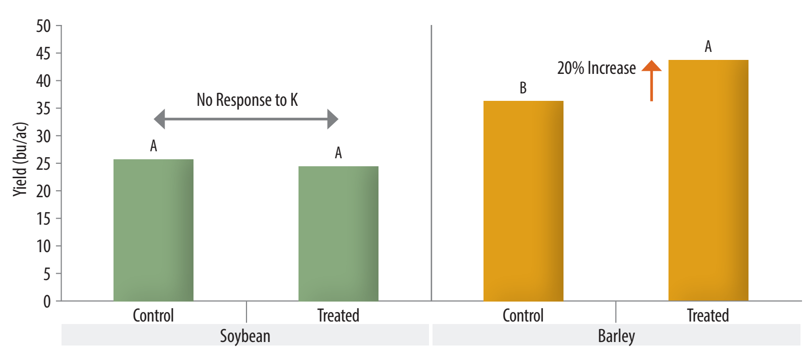
Table 1. Manitoba Soil Fertility Guide potassium (K) recommendations for soybean production.

Ammonium Acetate Soil Test K Level	Recommendation
>100 ppm	No additional K
50–75 ppm	30 lbs K_2O/ac broadcast and incorporated
<25 ppm	60 lbs K_2O/ac broadcast and incorporated

Overall, the frequency of soybean yield response to K fertilization was much lower than expected. The ammonium acetate STK threshold of 100 ppm proved to be an unreliable predictor of soybean response to K fertilization, but it did accurately predict barley yield response.

Soybean K response may be infrequent in Manitoba, but it is important to maintain K fertility throughout a rotation to support yields of other crops. Farmers can use expected soybean K removal rates and yields to estimate the amount of K fertilizer that is required to ensure adequate supply for all crops grown in rotation. Further research is needed to investigate the threshold for soybean K fertilization in Manitoba and to explore alternative soil tests that may be more accurate at predicting soybean K response than the current ammonium acetate method.

Figure 1. Soybean and barley responsiveness to potassium (K), at three site-years, comparing soils low in K (control) and soils treated with 120 lbs K_2O/ac, broadcast and incorporated prior to planting.



Different letters indicate significant differences ($p < 0.05$) between treatments.

PRINCIPAL INVESTIGATOR Dr. Don Flaten, University of Manitoba
MPSG INVESTMENT $60,314
CO-FUNDER Western Grains Research Foundation
DURATION 3 years

Evaluating Row Width and Plant Density for Dry Beans

Planting at narrow row widths of 7.5" and at moderate plant densities of 80–120,000 plants/ac resulted in the greatest, most stable yields in wet and dry years for navy and pinto beans.

MANITOBA IS CANADA'S largest producer of pinto beans and the second-largest of navy beans. Planting recommendations have stemmed from neighbouring regions and need validation under our local growing conditions.

Previous research has shown large yield increases (16–69%) by planting dry beans in narrow rows (< 15"). The objective of this research was to determine the plant density and row spacing combinations that maximize yield for navy and pinto beans in Manitoba.

Pinto and navy bean experiments were established at Carman and Portage over four years (2015 to 2018). Four row widths (7.5", 15", 22.5", 30") and five plant stand densities (pinto: 40–200,000 plants/ac and navy: 80–240,000 plants/ac) were evaluated for two varieties of each market class (Monterrey and Windbreaker pinto beans and Envoy and T9905 navy beans).

Environmental conditions played a large role year-to-year, so results were broken down to compare wet (2015 and 2016) and dry years (2017 and 2018). Precipitation was up to 77% lower than normal during dry years. Yields in wet years were 55% greater than dry years. In wet years, white mould was prevalent. Envoy had greater white mould severity ratings than T9905 navy beans, while there was no difference in severity between pinto bean varieties. Increasing plant density consistently increased white mould severity, while row width had less of an effect. Generally, white mould severity was lowest in 7.5" rows, followed by 30" rows and most severe in intermediate row widths. Planting dry beans in 7.5" rows at 120,000 plants/ac appeared to minimize white mould severity in wet years while still achieving high yields.

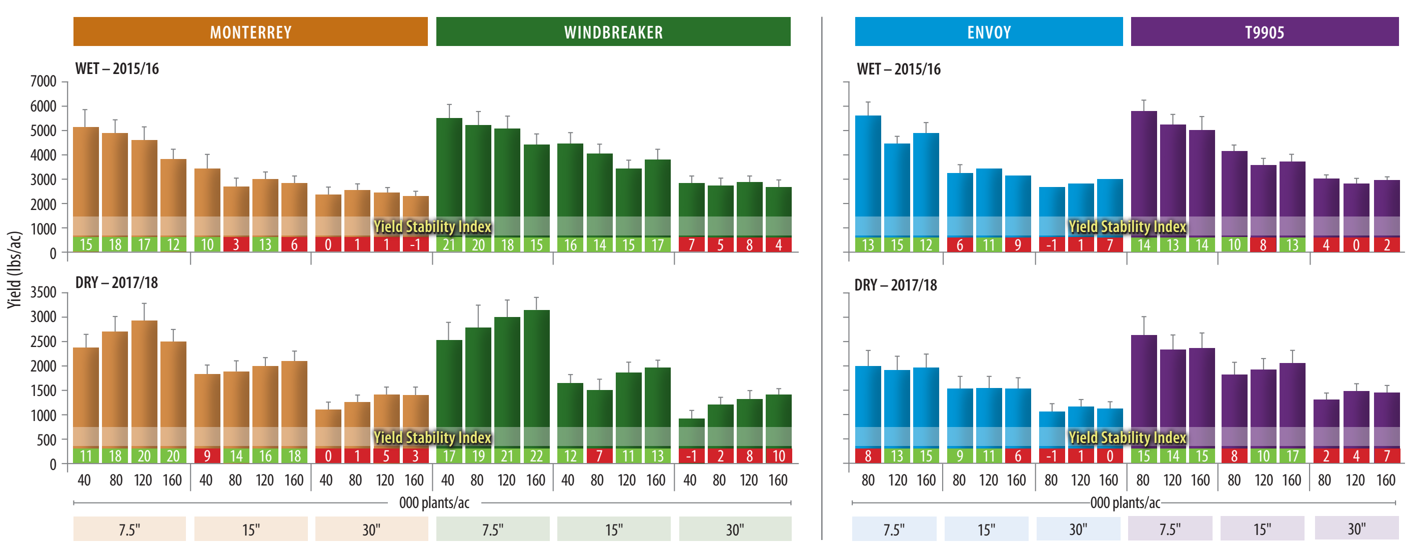
Yield stability is a measure of how much yield fluctuates year-to-year under different environmental conditions. Yields were greatest and the most stable (i.e., high yield stability index values) at narrow row widths combined with moderate densities for pinto and navy beans (Figure 1). T9905 yielded 15% more than Envoy and Windbreaker yielded 11% more than Monterrey.

During wet years, navy yield was greatest at 7.5" rows and 80,000 plants/ac, and pinto yield was greatest at 7.5" rows and 40–120,000 plants/ac. Yields decreased with wider row widths and higher plant densities.

During dry years, navy yield was only affected by row width, while both row width and plant density influenced pinto yield. Pinto yields increased with increasing plant density. In both navy and pinto beans, 7.5" row widths resulted in the greatest yields, followed by 15". Wide rows (30") resulted in the lowest yields.

Planting in narrow rows also produced in a more stable yield response. The most stable yield response in both navy and pinto beans was achieved by 7.5" rows at 120,000 plants/ac. The minimum plant density required to achieve high yields was 80,000 plants/ac.

Figure 1. Average yield (lbs/ac) and yield stability index for pinto (left) and navy (right) beans at Carman and Portage in wet (2015–2016) and dry (2017–2018) years.



PRINCIPAL INVESTIGATOR Dr. Robert Gulden, University of Manitoba

MPSG INVESTMENT $236,325

DURATION 5 years

Plant Density Effects on Shade Avoidance and Yield of Navy Beans Under Weed-Free and Weedy Conditions

Increasing plant densities resulted in greater yields, but enhanced shade avoidance characteristics like thinner stems, fewer branches and higher pods and did not reduce weed biomass.

HERBICIDE OPTIONS IN dry beans are limited and herbicidal weed control is often supplemented with inter-row cultivation. Other integrated weed management (IWM) tools are worth exploring to improve this uncompetitive crop's competitive ability, like row width, plant density and seeding date.

Plants will develop shade avoidance characteristics, or competitive characteristics, in response to detecting neighbouring plants. Once plants detect a neighbouring plant's presence, they try to grow to avoid that neighbour, resulting in thinner, longer stems and fewer branches. If plants dedicate too many resources to developing these characteristics when resources are limiting, yields will be reduced.

This research further investigated the yield-density relationship from the previous project, *Evaluating Row Width and Plant Density for Dry Beans* (page 4), under weedy and weed-free conditions, while also investigating the effect of seeding date.

At Carman in 2017 and 2018, a weed-free experiment was hand-planted in 7.5" rows at three plant densities (48, 96, 192,000 plants/ac). Shade avoidance characteristics like stem thickness, branch number, first internode length and lowest pod heights were evaluated in this weed-free experiment. A second, weedy experiment was established evaluating early (May 26 to 29) and late (June 14 to 19) seeding dates for two navy bean varieties (T9905 and Envoy) planted in 15" rows and at five plant densities (20, 40, 80, 160, 320,000 plants/ac). This experiment was used to generate yield-density relationships under weedy conditions.

Excessively dry conditions in 2018 resulted in the loss of the early-seeded experiment and poor emergence in the late-seeded experiment.

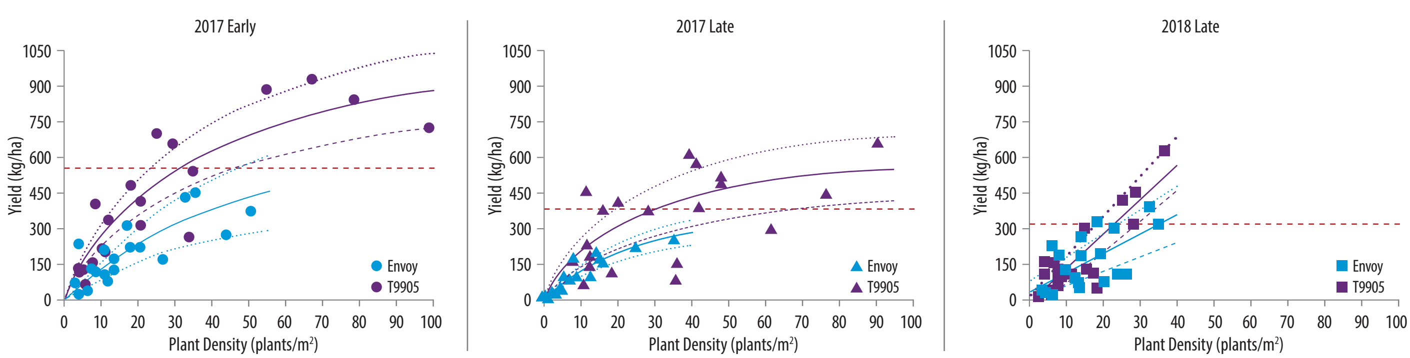
Yields increased with greater plant densities. Under weed-free conditions, increasing density also enhanced shade avoidance characteristics, resulting in thinner stems, fewer branches, longer first internodes and higher pods.

T9905 navy beans showed a better competitive response than Envoy navy beans, meaning they maintained yield with fewer plants under weedy conditions and developed fewer shade avoidance characteristics (Figure 1). T9905 has an indeterminate, upright growth habit, while Envoy is a determinate bush-type. Selecting competitive, upright varieties and planting at moderate densities are critical for maintaining yield when adequate weed control cannot be achieved.

In many crops, higher plant densities contribute to less mid-season weed biomass, a measure of weed pressure. In these experiments, increasing plant densities did little to reduce weed biomass under weedy conditions. However, weed pressure was very intense in these experiments. It can also be noted that the late-seeded experiment had less weed biomass than the earlier-seeded, likely due to seedbed disturbance at planting contributing some weed control.

A logical next step from this research would be to evaluate more dry bean varieties with different growth habits, in conjunction with other IWM tools, to improve dry bean competitiveness under weedy conditions.

Figure 1. Yields (kg/ha) of Envoy and T9905 navy beans planted early (late May) or late (mid-June) under weedy conditions at Carman in 2017 and 2018. The red dotted line represents average weed biomass (grams/m²).



PRINCIPAL INVESTIGATOR Dr. Robert Gulden, University of Manitoba

MPSG INVESTMENT $236,325

DURATION 5 years

PEST CONTROL

Novel Mechanical Weed Control Tools for Integrated Weed Management in Dry Beans

Narrow- and wide-row dry beans were tolerant to the rotative harrow at early crop stages. Herbicides were the most effective weed control tool. Pre-plant incorporated (PPI) herbicide alone was as effective as PPI plus one to two in-crop herbicide applications.

HERBICIDE OPTIONS FOR dry beans are limited, creating concerns over weeds developing herbicide resistance. Integrated weed management (IWM) strategies help sustain long-term herbicide efficacy in dry beans by reducing reliance on this single weed control tool.

Growing dry beans on narrow rows improves crop competitiveness with weeds. New camera-guided technology on inter-row cultivators allows for accurate tillage between narrow rows (Figure 1a). And new tillage tools, like the rotative harrow, have potential to be used post-emergence (Figure 1b).

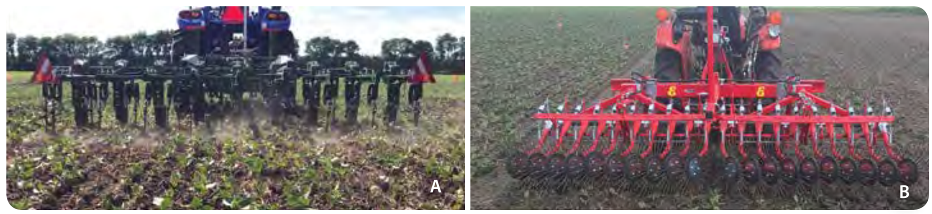
The objectives of this project were to:

1. evaluate the use of the camera-guided inter-row cultivator and rotative harrow in narrow-row dry beans
2. test the tolerance of narrow-row dry beans to the rotative harrow
3. integrate mechanical weeding tools and herbicides.

Two experiments were conducted at Carman in 2018 and 2019. The first experiment examined the tolerance of narrow-row dry beans (pinto, navy and black beans) to rotative weeding at different crop stages (VE/VC to flowering). The second experiment examined eight different weed control strategies involving herbicide, the rotative harrow and camera-guided inter-row cultivator.

Pinto, navy and black beans were tolerant to the rotative harrow at early crop stages in both narrow (6") and wide rows (24"). Mechanical disturbance at V1 yielded the greatest for pinto beans, possibly due to improved mineralized soil nitrogen from soil disturbance.

Figure 1. (A) Camera-guided inter-row cultivator and (B) Einbock Aerostar rotative harrow on 6" dry bean rows.

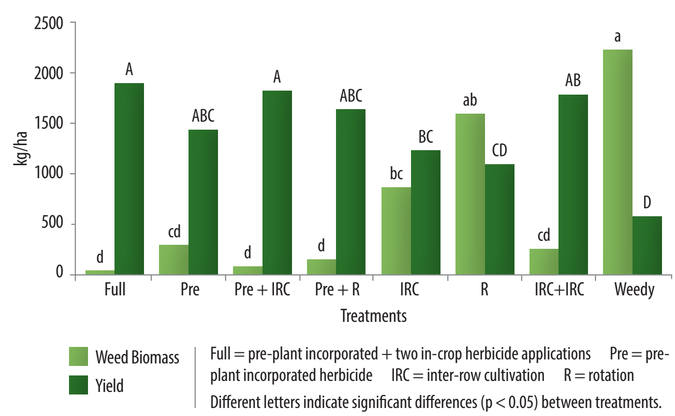


Herbicide application was the most effective at reducing weed biomass in dry beans. An exception was when inter-row cultivation with finger weeding was conducted twice during the growing season in wide-row pinto beans (Figure 2). In this case, weed biomass and yield were similar to treatments with herbicide. Pinto beans may be more tolerant to weed pressure than navy and black beans.

Pre-plant incorporated (PPI) herbicide on its own, or combined with a mechanical weed control tool, was generally as effective at controlling weeds and maintaining yield as PPI herbicide plus one to two in-crop herbicide applications.

The results of this study indicate that it is possible to reduce our reliance on in-crop herbicide applications in dry beans. However, this largely depends on the successful control of present weed species using a PPI herbicide. If no herbicides are used, inter-row cultivating twice on wide rows with finger weeding attachments is a viable weed management strategy. Overall, these results highlight opportunities to integrate different types of weed management strategies, both mechanical and herbicidal, to help prevent herbicide-resistant weed development.

Figure 2. Effect of weed management treatments on yield and weed biomass in wide-row pinto beans in 2019.



PRINCIPAL INVESTIGATORS Katherine Stanley and Dr. Martin Entz, University of Manitoba

MPSG INVESTMENT $68,200

CO-FUNDERS Canadian Agricultural Partnership

DURATION 2 years

PEST CONTROL

Manitoba Survey and Molecular Quantification of Soybean Cyst Nematode

Soybean cyst nematode was confirmed in Manitoba for the first time in 2019 in four out of 106 fields and four out of 18 municipalities sampled across all surveys (2012–2019). Cyst populations found in these four fields were extremely low and consistent with recent establishment of the pest.

SOYBEAN CYST NEMATODE (SCN, *Heterodera glycines*) is a microscopic roundworm that parasitizes soybean roots. Different types of nematodes can commonly be found in Manitoba, but not all are harmful to crops. SCN is a harmful type of nematode and one of the most damaging pests to soybean crops in North America.

Infestation of SCN can impact growth and yield by removing plant energy and nutrients, disrupting nutrient and water uptake, impeding root growth and opening plants to infection by soil-borne pathogens. Preventative action, early detection and timely management are key in avoiding significant yield loss from SCN. Once above-ground symptoms are noticed, up to 30% yield loss can already be expected.

This project is a continuation of the SCN survey initiated in 2012 to assess Manitoba fields for this pest. This second leg of the study was also launched to develop rapid, accurate molecular methods for quantifying any SCN found in the soil. The conventional quantification method is laborious and time-consuming, involving crushing cysts and counting eggs under a microscope. The availability of a molecular test would also benefit any region dealing with SCN.

In 2017, 30 soybean fields near the U.S. border with histories of soybean and dry bean production were sampled in October after harvest. Soil samples were collected from different risk areas of each field. Cysts were recovered from 12 of the 30 fields, of which seven had intact cysts containing eggs. However, only four of the seven fields had cysts that looked like they could be SCN. SCN was confirmed by visual and molecular DNA methods in these four fields.

This means four out of 106 fields and four out of 18 municipalities tested positive for SCN over the survey's entire history (2012–2019). Rural municipalities where SCN has been detected are Norfolk-Treherne, Rhineland, Emerson-Franklin and Montcalm (Figure 1).

No above-ground symptoms of SCN (e.g., stunting, chlorosis) were observed in these four fields. Cyst populations were also extremely low and consistent with the recent establishment of the pest, at one to 14 cysts per 5 lbs of soil. This is compared to populations of 3,000–4,000 cysts per 5 lbs of soil in Ontario and the U.S. Midwest where SCN has been present for many decades.

In July 2019, 20 fields in Ontario with a range of SCN levels and soil types were sampled to initiate work on the molecular quantification of SCN. Cysts were extracted from the soil samples and eggs were counted using the conventional method. DNA has been extracted from soils containing different numbers of eggs using extraction kits. Extracted DNA has been quantified for different soil types and SCN risk levels (none, low, moderate, high or very high) are now being developed. This research is ongoing.

Given the large gap between regions with positive identification, SCN may be present in fields not sampled during this survey. It is also possible that SCN may have established itself in additional fields since this survey was carried out due to its movement with soil. Routine surveillance and testing are recommended in Manitoba fields.

Once established, SCN can remain in the soil for many years. At this early stage of infestation, farmers can manage this pest before it causes significant soybean yield reductions. Populations of SCN can be minimized by rotating to non-host crops, growing resistant soybean varieties, controlling host weed species and cleaning machinery between field visits. Visit manitobapulse.ca or thescncoalition.com for more information on testing and management of SCN. ◗

Figure 1. Rural municipalities in Manitoba surveyed for soybean cyst nematode.

PRINCIPAL INVESTIGATOR Dr. Mario Tenuta, University of Manitoba

MPSG INVESTMENT $121,612

CO-FUNDER Western Grains Research Foundation

DURATION 3 years

On-Farm Evaluation of the Impact of Rolling Soybeans on Wind Erosion

The risk of wind erosion was greater in rolled treatments due to lower surface roughness, but the amount of soil moved by wind did not differ between rolled and unrolled treatments. Overall, the amount of soil loss by wind erosion was minimal.

Soil blowing near Carman in May 2018.

WIND EROSION IS the movement of soil by wind. Soil accumulates along field boundaries and roadside ditches, resulting in the loss of topsoil and nutrients from the field. Soil-covered snow is a visible example of soil movement by wind and is a common sight in Manitoba each year.

Soybean crops pose a greater risk of wind erosion due to later crop emergence in the spring and lack of crop residue in the fall, leaving soil exposed. Currently, there is little scientific information on wind erosion and soil loss in Manitoba.

There are concerns that the practice of rolling in soybeans may increase the potential for wind erosion. Since rolling pulverizes particles on the soil surface, they are more susceptible to movement by wind. In stony fields, the benefit of rolling to ensure a smooth harvest far outweighs the risk of wind erosion. But there may be the opportunity to avoid rolling in non-stony fields where harvestability and damage to the combine is not as much of a risk.

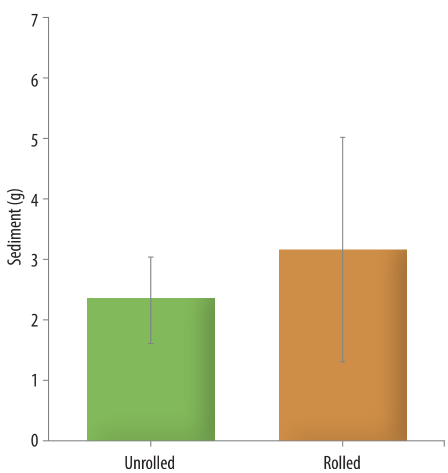
The objective of this research was to assess the effects of rolling on wind erosion. Non-replicated rolled and unrolled soybean strips were compared at eight non-stony On-Farm Network fields in the Red River Valley in 2018 and 2019. Fields were rolled within three days of seeding. The potential for wind erosion and amount of soil loss by wind was measured in rolled and unrolled strips. Young soybean plants were assessed for abrasion or sandblasting by windblown soil particles.

The potential for wind erosion was measured through soil surface roughness, stoniness, soil moisture content and crop residue cover. Actual wind erosion was measured using sediment traps in each treatment to capture any soil moved by wind. Field edges were surveyed for evidence of wind-eroded soil before seeding and after harvest.

Surface roughness is the main factor that influences the risk of wind erosion. An uneven or rough surface can better trap material, minimizing soil erosion from the field. Smoothing that surface through practices like rolling contributes to a greater risk of erosion.

In these experiments, rolling reduced soil surface roughness, increasing the risk of wind erosion. However, the actual amount of soil moved by wind and collected in the sediment traps did not differ between rolled and unrolled strips (Figure 1).

Figure 1. Soil movement by wind (grams of sediment) captured by sediment collectors in rolled and unrolled strips.



While measurable amounts of soil were collected from both treatments, the amount leaving the fields was too small to be measured. As a result, there was no evidence of soil movement away from the fields nor accumulation at field edges.

Wind erosion often occurs before the growing season even begins. For example, two severe wind erosion events happened in the spring of 2018, but they occurred before the trials were seeded and established. Once seedlings emerge, the risk of wind erosion decreases.

Abrasion of young soybean seedlings by sandblasting may cause crop damage, but it was not observed in this study.

Observations from this and other research in the region demonstrate that soil loss by wind erosion is minimal and unlikely to affect crop yields. While soil particles blowing through the air are very visible, this does not necessarily mean a significant amount of soil loss. In contrast, tillage or water erosion is a larger soil movement problem.

Surveillance of eroded soil along field edges and ditches in Manitoba is expected to continue, with particular attention to soybean fields. With soybeans and other low residue crops, the soil surface is more exposed to erosion in the fall and following spring. Future research should focus on soil conservation practices to reduce wind, water and tillage erosion in low residue crops and throughout the crop rotation.

PRINCIPAL INVESTIGATOR Dr. David Lobb, University of Manitoba

CO-FUNDER Canadian Agricultural Partnership

MPSG INVESTMENT $49,450

DURATION 2 years

On-Farm Evaluation of the Economics of Rolling Soybeans

Rolling costs about $5/ac and offers farmers peace of mind at harvest, even on non-stony fields. When rolling with larger tractors, a gear-up/throttle-down strategy can reduce costs.

LAND ROLLING PUSHES stones, residue root balls and soil clods down, aiding harvestability of soybean plants that pod low to the ground. Stones can cause significant damage to the combine leading to costly downtime during harvest. Rolling is a common practice in Manitoba, even on fields without stones where the risk of damage is minimal.

The objective of this research was to determine the cost of rolling and the economic return provided by rolling non-stony fields. This information can be used to help farmers decide whether rolling should remain part of their standard practices or if they can forego the extra pass on the field in spring.

Rolled and unrolled soybean strips were compared at six non-stony On-Farm Network fields in the Red River Valley in 2018 and 2019. Fields were all rolled with a smooth roller (50 ft) within three days after seeding. Fuel consumption (L/ac) was recorded. Draft load and power requirement were measured using an instrumented load cart between the power unit and the roller. Costs for rolling were calculated using the *Manitoba Farm Machinery Custom and Rental Rate Guide*. Header losses were assessed at harvest. The rock trap was monitored between strips to verify that no rocks were picked up, as rogue stones can emerge even in non-stony fields. Additionally, farm operators were asked a series of questions to gauge if rolling affected operator fatigue and comfort during harvest.

The average cost of rolling was $4.40/ac when an appropriately-sized tractor was used (< 300 hp, Table 1). However, most of the cooperating farmers used an oversized tractor (> 450 hp), either for trafficability or because that was the only unit available. In these situations, the cost of rolling was closer to $5/ac, but the use of a gear-up/throttle-down strategy can reduce fuel consumption and operating costs (Table 2).

The impact of rolling on seedbed placement was assessed at two site-years. Rolling did not affect seed depth, nor did it affect the amount of seeds stranded on the soil surface.

Operators did not feel the need to alter harvest speed between rolled and unrolled strips, nor did they notice any difference in handling equipment or ride comfort. However, all of the farmers felt the need to be more alert in the unrolled plots to watch for rogue stones or soil clods.

Header losses ranged from 1.4 to 3.9 bu/ac and showed no clear differences between unrolled and rolled strips. Unrolled strips had greater header losses at two sites, lower losses at one site and no difference from the rolled strip at another site. Extreme moisture in the fall of 2019 prevented further data collection.

Since there was no definitive indication of whether rolling affects header losses, farmers should measure harvest losses on their farms and decide whether to continue rolling by weighing the cost of rolling (approximately $5/ac) against the potential risk of equipment damage.

Table 1. Summary of roller operations and cost at six On-Farm Network sites.

Site	Tractor power (hp)	Roller diam/width (in/ft)	Speed (km/hr)	Draft force (lbs)	Power req (hp)	Work rate (ac/hr)	Fuel consumption (L/ac)	Custom rate ($/ac)
1	280	42, 50	12.7	2157	45.4	47.7	–	5.19
2	200	36, 50	13.0	1683	36.3	49.0	0.36	4.24
3	450	36, 50	15.8	1670	43.8	59.6	0.50	4.91
4	450	42, 50	17.3	1891	54.2	65.0	–	4.56
5	450	42, 50	15.9	2055	54.3	60.0	0.65	4.96
6	475	36, 51	15.1	1877	46.9	57.8	0.44	5.06

PAMI load cart connected between a power unit and a roller.

Table 2. Summary of gear-up/throttle-down strategy at two sites.

Site	Gear	Engine speed (rpm)	Speed (km/hr)	Work rate (ac/hr)	Fuel consumption (L/ac)	Cost savings per 1000 acres
5	15	1811	15.7	59.0	0.69	$ 0.00
	16	1498	15.9	60.0	0.65	$ 51.55
	17	1216	16.0	60.2	0.55	$ 168.01
6	13	1718	14.7	56.3	0.50	-$148.89
	14	1389	15.1	57.8	0.44	$0.00
	15	1109	15.2	58.5	0.36	$94.22

PRINCIPAL INVESTIGATOR Lorne Greiger, Prairie Agricultural Machinery Institute

MPSG INVESTMENT $43,245

CO-FUNDER Canadian Agricultural Partnership

DURATION 2 years

Residue Management Before Growing Soybeans

Tillage or straw removal from no-till cereal stubble resulted in warmer and drier seedbeds, but this had little effect on emergence or yield when soybeans were planted into soils at ≥15°C.

SOYBEANS ARE SENSITIVE to cold temperatures during early development. It is recommended to plant soybeans when daily average soil temperatures are above 10°C. Residue management before soybean planting may be one tool to modify early-season soil conditions for better plant establishment, especially in short-season areas like western Manitoba.

The objective of this research was to determine if residue management practices ahead of soybeans would have an impact on soil temperature and moisture at planting, or on soybean emergence, yield and quality.

Six residue management treatments were assessed at Brandon, Carberry, Portage and Roblin over three years (2015 to 2017). Residue management treatments included: 1) tilled wheat residue, 2) wheat straw chopped and returned, 3) wheat straw removed, 4) oat straw chopped and returned, 5) oat straw removed and 6) canola straw chopped and returned.

Soybeans were planted from mid- to late-May. Soil temperature and moisture at seeding depth were measured at planting. Days to emergence, plant stand and yield were evaluated.

Soil temperatures at planting ranged from 15°C to 25°C, regardless of the residue management treatment (Figure 1).

Tillage increased soil temperature compared to no-till treatments, on average, by 1°C to 5°C (7 of 12 site-years). Tillage generally reduced (6 of 12 site-years) or had no effect on soil moisture (6 of 12 site-years) compared to no-till treatments. Straw removal increased soil temperature by <1°C to 3°C (7 of 12 site-years) and reduced soil moisture (5 of 12 site-years) compared to no-till treatments with straw. Canola stubble with straw returned had a more variable effect with no clear trend observed.

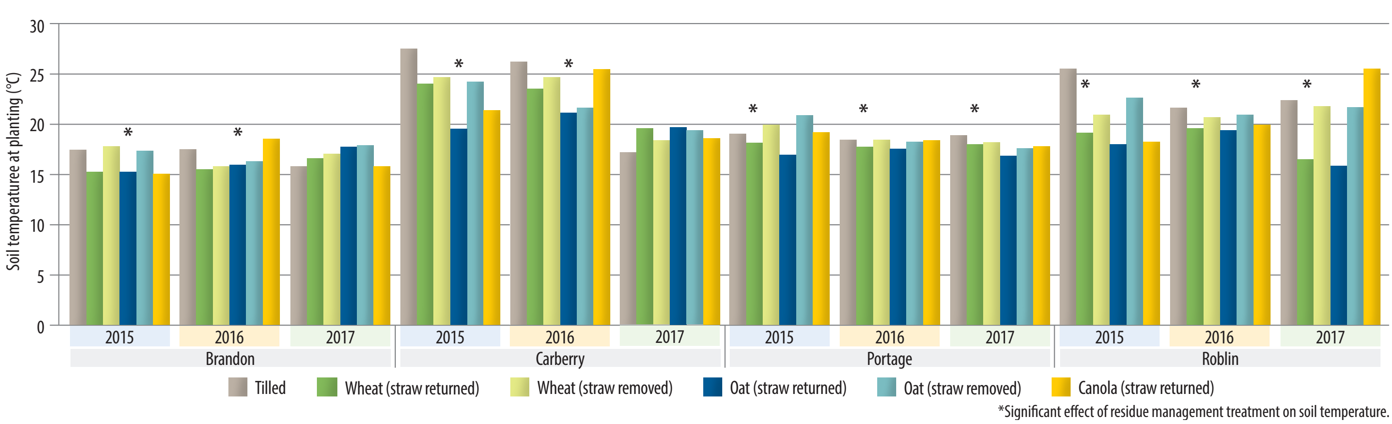
Based on a visual assessment, days to emergence were similar regardless of residue management treatment. There was also no significant effect on plant stand from emergence to 30 days after planting.

Soybean yield was unaffected by residue management practices at 10 of 12 site-years. At Brandon in 2017, the tilled treatment yielded more than other treatments (3.5 bu/ac more), but no difference in soil temperature or moisture at planting was measured. At Brandon in 2016, yield was 6.6 bu/ac more following canola than wheat with straw removed. This may have been due to the higher rate of nitrogen fertilizer applied in the spring to compensate for lower soil test N following canola.

Temperature differences at planting may not have been great enough to influence crop performance, or soybeans were able to compensate for any small differences throughout the growing season. Soil temperatures at planting were ≥15°C in all treatments and soybeans were planted during the recommended planting window. Under more marginal growing conditions with earlier planting dates and cooler temperatures, there may be an effect of residue management practices on soybeans.

To assess this, a follow-up study was started in 2017 to determine if there is an effect of residue management when soybeans are planted into marginal conditions and under additional residue management practices (tall vs. short stubble, stubble burning). Results are expected in 2022.

Figure 1. The effect of six residue management practices on soil temperature (°C) at planting at Brandon, Carberry, Portage and Roblin from 2015 to 2017.



PRINCIPAL INVESTIGATOR Dr. Ramona Mohr, Agriculture and Agri-Food Canada – Brandon

MPSG INVESTMENT $49,600

CO-FUNDERS Western Grains Research Foundation, Agri-Food Research and Development Initiative

DURATION 4 years

Processing Effects on the Cholesterol-Lowering Benefits Associated with Eating Beans

Cooking method and milled particle size influenced the cholesterol-lowering ability of black beans. Micronization (infrared heating) and coarse milling were better at lowering blood cholesterol.

A– black beans prepared by extrusion and fine milling

B – cooked and freeze-dried black beans

C – uncooked whole black beans

Changes in physical characteristics due to processing are usually visible, but modifications to the chemical characteristics that determine their ability to affect health cannot be determined without testing.

EATING WHOLE PULSES and soybeans helps lower blood cholesterol. However, the North American population typically does not consume large amounts of whole pulses and soybeans (consumption by Winnipeggers was estimated at less than a one-third cup per month). Instead, they prefer easy-to-use recipes or prepared foods that utilize processed ingredients. But it remains unclear whether processing affects the health benefits of the whole food.

If pulses are processed to flour or different fractions, we need to know which part of the seed contains the compounds responsible for the health benefits. We also need to know if different methods of cooking or heat treatment might affect these compounds. For example, new foods are being developed that contain pulse flour or fractions of the whole seed, micronization (infrared heating) is being used to expedite the cooking process and extrusion is being used to develop snacks containing pulses.

The goal of this project was to determine whether processing methods affect the cholesterol-lowering properties of black beans. Black beans were chosen, as a previous research project demonstrated that whole black beans prepared by conventional methods (overnight soaking and boiling) lowered blood cholesterol.

Black beans were prepared using five different methods:

1. conventional preparation including overnight soaking and boiling, followed by freeze-drying and milling to a fine powder
2. the same method as (1) but milling to a coarse powder
3. extrusion into a Cheetos-like product then fine milling
4. micronization then fine milling
5. dehulling with a pearler, followed by the same method as (1).

These bean powders were subjected to a nutrient analysis then incorporated into rodent diets and compared with a bean-free control diet.

Processing method affected the cholesterol-lowering properties of black beans. More specifically, both cooking method (type of heat treatment) and particle size (milling) played important roles.

Black beans prepared by micronization, but not extrusion, lowered total cholesterol and low-density lipoprotein (LDL) cholesterol (i.e., "bad" cholesterol). Micronizing black beans resulted in lower insoluble fibre and total dietary fibre, yet they were effective at lowering cholesterol. This suggests that the amount of insoluble fibre and total dietary fibre (as they would appear on a food label) does not necessarily predict the degree of cholesterol lowering.

Coarse vs. fine particle size plays a role in the cholesterol-lowering ability of black beans. In this study, the conventional preparation of beans (soaking and boiling) plus milling to a coarse powder lowered LDL-cholesterol, whereas milling to a fine powder did not. All other preparation methods were followed by fine milling and it is possible they may have been more effective at cholesterol-lowering if coarse milling had been used.

Dehulled, cooked black beans lowered total cholesterol, indicating that the bioactive components for cholesterol-lowering are present in the cotyledon part of the seed. Isolated fractions or flours that contain primarily cotyledon would be expected to have cholesterol-lowering properties as well.

In summary, the method used for bean processing can affect the cholesterol-lowering ability of black beans. This must be taken into account when new food products are being developed that utilize different methods of heat treatment or milling, or those that produce isolated fractions of the whole seed.

Unfortunately, a universal conclusion cannot be reached regarding which processing method is the best and it will be necessary to perform a similar study for every health benefit that is expected to be present in new products containing black beans.

PRINCIPAL INVESTIGATOR Dr. Peter Zahradka and Dr. Carla Taylor, St. Boniface General Hospital Research Centre

MPSG INVESTMENT $67,907

DURATION 2 years

MARKET DEMAND

Reducing Blood Sugar with Beans – Defining the Minimum Serving

Eating a quarter cup of beans results in a significantly lower blood sugar (glycemic) response than a similar amount of starchy foods like rice, pasta, potatoes or corn.

EATING BEANS HAS been proven to result in a relatively low glycemic (blood glucose or blood sugar) response compared to other starchy foods. However, previous studies have tested serving sizes of one to two cups, which may not be achieved in a typical meal.

The current study assessed the blood glucose response of beans consumed at quarter- and half-cup portions compared to similar amounts of common starchy foods.

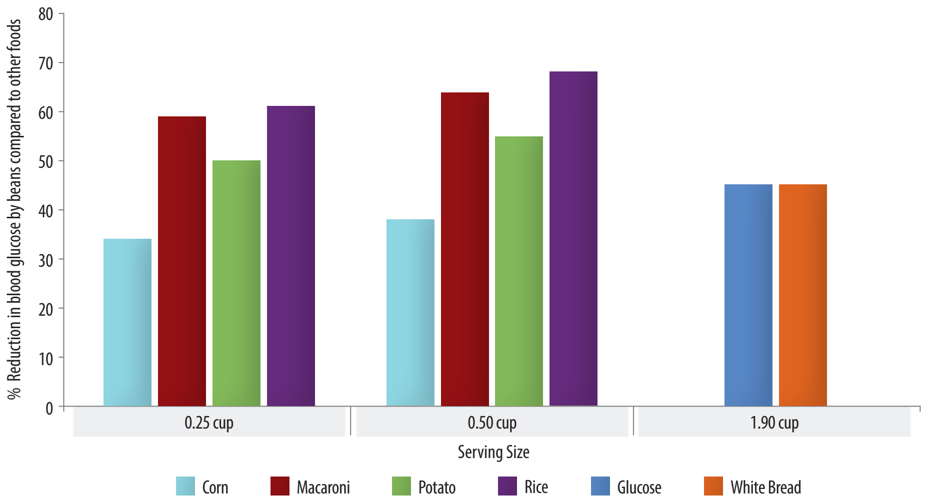
Six commonly consumed Canadian beans (pinto, navy, black, cranberry, red kidney and great northern) and four starchy control foods (white rice, macaroni, instant potatoes and corn) were consumed by 42 healthy volunteers in this study. Either quarter- or half-cup portions were eaten after an overnight fast and blood glucose response was measured over a two-hour period.

Results showed that both quarter- and half-cup servings of beans resulted in lower glycemic responses than the same quarter- or half-cup servings of corn, macaroni, potatoes or rice (Figure 1). The difference between beans and corn was smaller than for the other foods; the average glycemic response for the six types of beans was 34% less than that for corn. The average glycemic response of the six bean types was 59% less than that of macaroni, 50% less than potatoes and 61% less than rice. The magnitude of blood glucose reduction was similar when beans were consumed at either a quarter or half cup.

Compared to a quarter cup of commonly consumed starchy foods, the same amount of beans lowered the relative blood glucose response by 21–48%. A blood glucose reduction by at least 20% is deemed a significant effect by Health Canada. This research can be used to guide regulatory approval of a health claim for bean consumption.

Previous studies confirmed that one cup of cooked beans was the minimum effective serving for lowering blood glucose levels following a meal. This research supports that the minimum effective dose of beans in a meal may be lowered to a more achievable serving of a quarter cup.

Figure 1. Reduction in blood glucose when beans are consumed vs. common starchy foods.



PRINCIPAL INVESTIGATOR Dr. Dan Ramdath, Agriculture and Agri-Food Canada – Guelph

MPSG INVESTMENT $16,000

CO-FUNDERS Agriculture and Agri-Food Canada, Ontario Bean Growers

DURATION 1 year

MARKET DEMAND

Performance of Pea vs. Cellulose Fibre in White Bread

White bread enriched with pea fibre had several benefits over cellulose fibre. However, specific dough handling and bread quality characteristics need improvement to enhance the competitiveness of pea fibre in the U.S. market.

DEMAND FOR DIETARY fibre has increased due to its ability to reduce cholesterol, blood glucose and some types of cancer, among other health benefits. The recommended daily fibre intake is 20–35 g, but most of the population only consumes 10–15 g/day.

As more consumers are drawn to the health benefits of fibre consumption, there is a greater demand for fibre-rich foods. White pan bread is a staple of western diets, but it typically lacks fibre.

Fibre can be derived from many sources, including peas, wheat, oats and cellulose (wood), with each fibre ingredient possessing unique functional, nutritional and quality attributes. In Canada, pea hull fibre can be used for bread enrichment, but cellulose fibre is not permitted. In the U.S., lower-priced cellulose fibre is allowed in bread and has replaced pea fibre in that market.

The objective of this research was to identify advantages and challenges associated with using pea fibre in bread that might lead to greater competitiveness in the U.S. market.

Three pea fibres and two cellulose fibres from different manufacturers were added to white bread, targeting 2 g fibre/50 g bread serving. Fibre properties (content, particle size, water-holding capacity, antioxidant level), dough mixing properties (development time, mixing tolerance index, mixing time and energy), bread quality indicators (oven spring, loaf volume, moisture) and sensory attributes (crumb grain and texture, aroma, flavour) were evaluated. Bread quality and sensory properties were assessed after one and seven days.

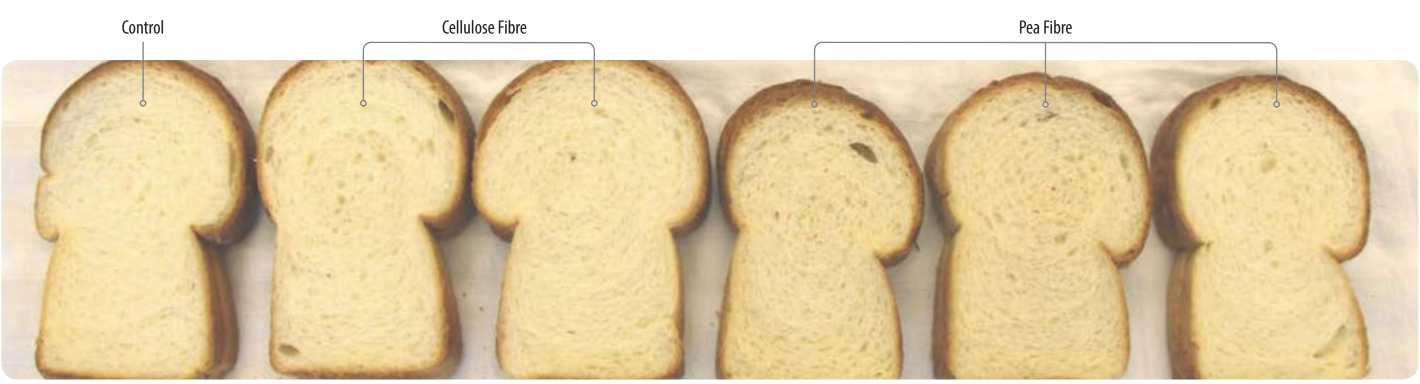
Bread enriched with pea fibre had a similar flavour and overall quality as breads made with cellulose fibre and those without added fibre (control). Compared to the cellulose and control breads, pea fibre bread had a softer crumb, better moisture retention and more antioxidant activity after seven days of storage. Pea fibre addition also reduced dough mixing time, improved mixing tolerance and required slightly less energy to develop the dough over cellulose fibre.

Challenges associated with pea fibre addition included longer dough development time and reduced loaf volume and oven spring (i.e., final burst of rising when a loaf is put in the oven), compared to the cellulose and control breads. However, adding either type of fibre generally reduced loaf volume and oven spring because the fibre replaced flour (gluten), which provides dough structure to aid rising.

Compared to cellulose fibre, pea fibre had less total dietary fibre content but more soluble fibre and antioxidants. More pea fibre was needed than cellulose fibre to obtain 2 g of total dietary fibre per slice of bread. Pea fibre also increased the cost of the flour/fibre blend (+$2.06 to $5.57/kg as of 2013) compared to cellulose fibre.

This research suggests that pea fibre can be used to produce fibre-enriched white bread with comparable dough handling and product quality to cellulose bread. Pea fibre also has several advantages over cellulose fibre. However, further research is required to improve certain dough handling and bread quality characteristics. Future research to enhance market competitiveness might include fibre hydration for quicker dough development time or the addition of wheat gluten for better oven spring and loaf volume.

The interior crumb of the control white bread compared to those enriched with cellulose and pea fibre.



PRINCIPAL INVESTIGATOR Janice Meseyton, Food Development Centre

MPSG INVESTMENT $27,000

CO-FUNDERS Best Cooking Pulses dba Avena Foods Limited

DURATION 2 years

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