VOLUME 4

PULSE RESEARCH

Growing the Output of the Pulse Industry

Development of New Crop Options

The Link Between Sustainability and Pulses

Creating a Healthier World With Pulses

SASKATCHEWAN pulse Growers

VOLUME 4

PULSE RESEARCH

Developing More Options:
Supporting faba beans and soybeans as new crop options for Saskatchewan

Building New Markets:
Exploring how pulses create a healthier world

Upholding Pulse Sustainability:
Making the link between pulses and sustainability

Gaining Ground:
Growing the output of Saskatchewan's pulse industry

On the cover: Dr. Diane Knight examines chickpeas in the phytotron at the University of Saskatchewan


02
DEVELOPING MORE OPTIONS
pages 14–23
01
GAINING GROUND
pages 4–13
03
UPHOLDING PULSE SUSTAINABILITY
pages 24–33
04
BUILDING NEW MARKETS
pages 34–43

01

Dr. Chris Willenborg is looking at integrated management strategies to help with weed control in pulse crops.

GAINING GROUND

How research is helping to grow the output of Saskatchewan's pulse industry

01 GAINING GROUND

One of Saskatchewan Pulse Growers' (SPG) major research goals is making overall economic gains for the pulse industry in the province.

How does this happen?

By addressing the organization's research priorities, says Dr. Lisette Mascarenhas, Director of Research and Development.

One of these priorities is increasing the production of pulses.

"This area includes everything from pre-breeding work, to variety development, to determining how varieties that are released adapt to the environment, to honing best management practices for growers to grow the varieties that are released," she says.

Another priority is removing production constraints by addressing issues that affect and impact pulse production in Saskatchewan, including pests (diseases, insects, and weeds), nutrient management, water management, and more.

SPG regularly seeks input from industry members such as growers, agronomists, and researchers, to continually update what the constraints are, Mascarenhas says.

"We then focus on research that would help find solutions to remove these constraints," she says.

Finally, economic gains are achieved through developing new pulse crop options for Saskatchewan growers. SPG currently has a goal to develop at least one viable pulse crop option for every acre of farmland in Saskatchewan.

"We encourage growers to grow pulses because of their economic and environmental benefits, so we need to have options for them to choose from," Mascarenhas says.

These three research priority areas are all equally important, as one does not work without the other.

"It is not just about having varieties available, it is also having agricultural practices and best management practices that growers can adopt to successfully grow them," Dr. Mascarenhas says.

SPG is currently funding ongoing research in all three areas, aiming to provide information that will help answer the ultimate question: how can we grow the output of Saskatchewan's pulse industry? Here is a look at some of this research.

Pre-Breeding Work

Before you can breed new, improved pulse varieties, you need to know exactly how to make them better than previous varieties. And this is where a lot of SPG-funded research begins.

For example, one of the major problems currently affecting pulse growth in Saskatchewan is *Aphanomyces* root rot caused by the *Aphanomyces euteiches* pathogen. Since it was discovered in the province in 2012, this pathogen has severely affected pea and lentil crops in the province, and there are currently no effective management options available aside from avoiding growing susceptible crops for a minimum of six years.

Dr. Sabine Banniza, Plant Pathologist at the University of Saskatchewan's (U of S) Crop Development Centre (CDC) and a Professor in the U of S Department of Plant Sciences, has been working to combat this issue for years, and has made some modest gains.

She recently completed a research project that aimed to produce *Aphanomyces*-resistant lentil varieties through rapid generation technology (RGT) involving wild lentil crosses. The use of RGT was a success, in that it will help speed up and fuel ongoing research that will screen for *Aphanomyces* resistance in the wild lentil germplasm, she says.

What is rapid generation technology?

Dr. Tom Warkentin, Professor with Department of Plant Sciences and Plant Breeder with the CDC at the U of S, explains: "With rapid generation technology (RGT), plants are grown under conditions that result in miniature plants which flower and mature earlier than

Aphanomyces root rot was first discovered in Saskatchewan in 2012 and has since become a major problem for pulse growers. SPG-funded research has since made progress in developing Aphanomyces-resistant varieties of peas.

under normal growing conditions. Miniaturization is achieved by growing the plants in crowded conditions and/or by applying plant hormones that shorten plant internodes. Before the resulting seeds are fully mature, they are excised and replanted to start the next generation."

"Whatever resistance we identify will be used for crossing and then we can use the rapid generation technology for wild lentil to advance the material as quickly as possible. This will also be very useful to develop populations for the development of molecular markers for *Aphanomyces* resistance in lentil as quickly as possible."

THE CDC IS CURRENTLY DOING IMPORTANT PRE-BREEDING WORK WITH LENTILS, AIMING TO DIVERSIFY THE CULTIVATED GERMPLASM AVAILABLE TO BREED NEW VARIETIES.

Banniza's current research, which aims to integrate *Aphanomyces* resistance screening into RGT for lentils and peas, has also made progress developing partially resistant pea varieties. At this point they have crossed seven adapted pea varieties with partially resistant United States Department of Agriculture (USDA) pea lines developed by colleagues in the United States (U.S.) and France.

"We are very lucky that other research groups have already done a lot of the screening in peas," Banniza says. "We are miles ahead because of this, because identifying sources of resistance can be a very painstaking and long process."

Through additional funding from SPG, the team has now been able to adopt molecular markers to help identify resistant lines. They are now screening for those markers, and will advance lines to see if they have partial resistance.

"This will become the first generation of *Aphanomyces*-resistant varieties using one source of resistance," Banniza says.

If all looks positive, the pea lines could be entered into co-operative trials within three years, where they would have to undergo two years of testing before they could be released, she says.

This offers some light at the end of the tunnel for Saskatchewan pea growers. In terms of developing lentil varieties with resistance, however, we are a bit further behind.

Banniza and her team have screened a selection of lentil cultivars trying to find some resistance, and found none. They also recently screened some Iranian lentil landraces from the USDA that were identified with partial resistance, but the results have not been positive so far, Banniza says.

"It could be that our isolates are a bit more aggressive than those used at USDA when they originally screened that germplasm," she says. "We will screen the germplasm again with an improved protocol for pathogenicity testing."

One bright spot in this research, however, is that *Aphanomyces* is an issue currently being addressed by researchers internationally, and therefore growers stand to gain from progress made elsewhere in the world, according to Banniza.

"We know that our USDA colleagues are working in more detail on this, so we will focus more on the wild lentil germplasm while they concentrate on the domesticated lentil species. This way, we all get ahead faster."

At the CDC, breeders are also working with genomics to develop new varieties of chickpeas, a crop that has fluctuated in recent years due to weather and market conditions.

"It is still challenging for growers to produce chickpeas," says CDC breeder and U of S Associate Professor Dr. Bunyamin Tar'an. "They require dry and

warm conditions and since 2010 we have been in a wet cycle. This is a crop that when you grow it, you really need to pay close attention and do your due diligence."

Although there have been major improvements with some of the current varieties, there will always be work to be done in breeding chickpeas, Tar'an says.

One of the benefits of working with this crop is that the genomic sequencing for chickpeas was completed back in 2013, making it further advanced in this respect than other pulse crops such as peas and lentils. Tar'an is currently using these tools in his chickpea breeding program that involves genomic selection and resequencing.

"You create a population as you are training and you create a statistical model and use it to make selections into your breeding lines," he says. "Right now, we are testing it with several traits, including those that we know, to see how accurate the technique is and how much genetic gain we can get. We are still answering a number of questions but this will help us bring a better product quicker to growers."

The overall goal of the chickpea breeding program is to breed varieties that have shortened time to maturity under Saskatchewan growing conditions, and improved disease resistance. The CDC breeders are also working on improving the crop for food processing and end-use consumer markets, by improving the functionality and nutritional traits of chickpeas.

The CDC is currently doing important pre-breeding work with lentils, aiming to diversify the cultivated germplasm available to breed new varieties. This research is important to maintaining the productivity and output of the lentil industry, which has seen an annual yield gain of more than three per cent since 2001.

Superior Varieties

At the CDC, pulse breeders are continually working on developing new varieties that have improved traits such as higher yield potential, improved disease resistance, better seed quality, and more.

Dr. Tom Warkentin is one of these breeders, focusing primarily on peas.

SPG has invested nearly $23 million dollars in pulse crop breeding over a five-year period at the Crop Development Centre.

01 GAINING GROUND

"We have a large breeding program on peas and the majority of germplasm testing is done in Saskatchewan," he says. "By being based here, by having a large program with diverse material, and by testing it under the wide range of conditions that are present in Saskatchewan, we are able to select material with higher yield for the growers."

One of Warkentin's current research projects is a genomic study focused specifically on introducing new diversity into pea breeding material to improve key traits in the crop.

"By crossing then selecting with markers, we are going to put small segments of chromosomes from five different donor parents into CDC Amarillo, which is one of our recent high-yielding varieties, and then we are going to look at resulting lines in the field and determine whether they are adding something extra to the variety," he says.

The donor parents have been carefully selected for their ability to potentially add valuable traits to the new lines, including resistance to *Aphanomyces* and *Ascochyta,* higher protein concentrations, greater resistance to heat during flowering, and more.

The research will continue over the next two years, at which point Warkentin hopes to have solid leads into improved pea varieties.

"Improved varieties, or at least improved parents for breeding, may come directly out of this resource," he says.

There is also some exciting variety development work being done at the CDC with faba beans.

Although the CDC began breeding this crop decades ago, interest is currently picking up, says Tar'an.

"Because of the wet conditions we have had here in the past years, and problems with root rot, people really need alternatives in their rotations," he says.

Faba beans are especially appealing right now as they perform better in wet conditions and have partial resistance to *Aphanomyces euteiches.*

There are two types of faba beans, one is larger seeded with coloured flowers, which is more suited to the food market, and the other is smaller seeded with white flowers, which is a zero-tannin market class, making it a better fit for the feed market and for fractionation.

"The tannins have some negative impact for the feed market because they lower the energy to the animal, so with zero-tannin we minimize the problem," says Tar'an.

Smaller seeds are also preferable to growers, as they are easier to seed and have lower seeding costs.

The CDC is currently working on developing new breeding lines of both white and coloured flowered faba bean with small and large seed size that can tolerate drier conditions (faba beans do not do as well with dry conditions), have disease resistance (especially to chocolate spot), and that have low vicine and convicine levels, making them safe for human consumption.

Tar'an says we are not too far away from having new faba bean varieties with the low vicine and convicine levels.

"There is some potential amongst our current breeding lines," he says.

Weeds as a Constraint

One of the major issues facing all Saskatchewan pulses right now is herbicide-resistant weeds, says Dr. Chris Willenborg, Assistant Professor, Plant Sciences at the University of Saskatchewan.

"We have all seen lentil fields that look like an intercrop of mustard, but this is in fact Group 2-resistant wild mustard," he says.

Within the past five to seven years, several forms of resistance have been identified in Western Canada, including Group 2, 4, and 9 herbicide-resistant kochia.

"Group 2-resistant cleavers is also a challenge for pea growers, and Group 2-resistant kochia, stinkweed, and

Thanks to his work on sequencing chickpea germplasm, Dr. Bunyamin Tar'an has helped this pulse crop adapt to growing conditions in Saskatchewan.

wild mustard are problematic in many of the lentil-growing regions of the province," Willenborg says.

In light of this, he is currently working on a research project with Eric Johnson, Research Associate with the Department of Plant Sciences at the University of Saskatchewan, looking at how to better manage the growing challenge of herbicide-resistant weeds in pulse crops, and how to use integrated solutions that improve weed control and reduce the cost of weed management to pulse growers.

An integrated approach to managing the problem is a must, he says.

"We are working on many different avenues to tackle this, including better understanding of weed seed predators and their contribution to weed control in pulse crops, improved cropping systems that would improve management of weeds, and improving operational diversity in pulse crop production through optimization of various management practices."

This research is a multi-year project that kicked off in 2016. It is too early to discuss results, Willenborg says, but he hopes that when it wraps up in 2021 they will have new information that can be immediately put into practice by growers. For now, he cautions growers to start considering longer-term, more integrated strategies to manage herbicide-resistant weeds.

"Breeding herbicide tolerance to another mode of action into a crop will buy us some time, as will stacked herbicide-tolerant traits. However, these will ultimately select for yet more resistance to other modes of action. Probably the best time to start resistance management planning was yesterday, although there is a definitely a bit of a 'it cannot happen to me' attitude or 'why worry about what is not yet ailing me?' But in reality, what we know is that an ounce of prevention now is worth a pound of cure in the long-run."

SPG is also funding other research in the area of controlling weeds, diseases, and improving agronomic practices.

01 GAINING GROUND: PROJECTS FEATURED

PROJECT TITLE	INVESTIGATORS	FUNDERS	END DATE
50K Single Nucleotide Polymorphisms (SNP) Chip Development for Genomic-Enabling Chickpea Breeding	Dr. Bunyamin Tar'an, University of Saskatchewan **Co-investigator(s):** Amit Deokar, University of Saskatchewan	Saskatchewan Pulse Growers ($921,998)	December 31, 2020
Application of Genomics to Innovation in the Lentil Economy (AGILE)	Dr. Kirstin Bett, University of Saskatchewan, Dr. Doug Cook, University of California-Davis **Co-investigator(s):** Dr. Bert Vandenberg, University of Saskatchewan	Saskatchewan Pulse Growers ($1,517,688 CAN, $534,876 USD), Genome Canada, Western Grains Research Foundation	September 30, 2019
Developing Rapid Generation Technology Involving Wild Lentil Crosses in Order to Produce *Aphanomyces* Resistant Lentil Varieties — Proof of Concept	Dr. Sabine Banniza, University of Saskatchewan **Co-investigator(s):** Dr. Bert Vandenberg, Dr. Monika Lulsdorf, University of Saskatchewan	Saskatchewan Pulse Growers ($258,289)	April 30, 2017
Development of Adapted High Yielding Faba Bean for Saskatchewan	Dr. Bunyamin Tar'an, University of Saskatchewan **Co-investigator(s):** Dr. Bert Vandenberg, Hamid Khazaei, University of Saskatchewan	Saskatchewan Pulse Growers ($675,257)	March 31, 2020
Development of Improved Markers for Mycosphaerella Blight Resistance in Pea	Dr. Tom Warkentin, University of Saskatchewan **Co-investigator(s):** Dr. Bunyamin Tar'an, Dr. Sabine Banniza, Dr. Ambuj Bhushan, University of Saskatchewan	University of Saskatchewan ($185,150), Agriculture Development Fund, Western Grains Research Foundation	June 30, 2016
Dry Bean Improvement for Sustainable Production in Canada (Sub-activity 5: Development of dry bean germplasm and varieties adapted to south-western Ontario)	Dr. K. Peter Pauls, University of Guelph **Co-Investigator(s):** Dr. Kirsten Bett, University of Saskatchewan, Dr. Robert Conner, Dr. Lorna Woodrow, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($125,000), Agriculture and Agri-Food Canada, Ontario Bean Growers	March 31, 2018
Cover Cropping as Part of a Rotation Strategy to Reduce Pea Root Rot	Dr. Syama Chatterton, Agriculture and Agri-Food Canada **Co-investigator(s):** Dr. Steven Shirtliffe, Dr. Sabine Banniza, University of Saskatchewan, Frank Larney, Agriculture and Agri-Food Canada, Robyne Bowness, Alberta Agriculture and Forestry, Leila Hrapovic, Government of Canada, Jamie Larson, Newton Lupwayi, Brian Beres, Agriculture and Agri-Food Canada, Henry de Gooijer, Government of Canada	Saskatchewan Pulse Growers ($433,832)	March 31, 2021
Effect of Seeding Rate and Seed Size on Lentil Diseases, Weeds, Yields, and Profitability	Dr. Steven Shirtliffe, University of Saskatchewan	Saskatchewan Pulse Growers ($65,580), Agriculture and Agri-Food Canada, Western Grains Research Foundation	March 31, 2017
Enhancing Weed Science in Pulse Crops: Towards a robust strategy for long-term weed management	Dr. Chris Willenborg, University of Saskatchewan **Co-investigator(s):** Eric Johnson, University of Saskatchewan	Saskatchewan Pulse Growers ($2,023,021)	March 31, 2021
Epidemiology of Chocolate Spot of Faba Bean	Dr. Syama Chatterton, Agriculture and Agri-Food Canada **Co-investigator(s):** Robyne Bowness, Alberta Agriculture and Forestry, Dr. Sabine Banniza, University of Saskatchewan	Saskatchewan Pulse Growers ($121,296), Agriculture Development Fund	March 31, 2021
Genetic Analysis of Flowering Genes and Their Associated Effects on Agronomic Performance and Stress Tolerance in Chickpea	Dr. Bunyamin Tar'an, University of Saskatchewan	Saskatchewan Pulse Growers ($172,737), Agriculture Development Fund	December 1, 2019
Improving Agronomic Practice / Managing Herbicide Resistant Weeds in Pulses with Alternative Modes of Action	Dr. Hugh Beckie, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($12,000), Agriculture and Agri-Food Canada	March 31, 2018
In-Crop Weed Clipping for Weed Control	Dr. Steve Shirtliffe, University of Saskatchewan **Co-investigator(s):** Breanne Tidemann, Dr. Neil Harker, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($144,320), Agriculture Development Fund, Saskatchewan Wheat Development Commission, Alberta Wheat Commission	June 30, 2020
Infectivity Model for *Aphanomyces Euteiches* in Saskatchewan Soils	Dr. Syama Chatterton, Agriculture and Agri-Food Canada **Co-investigator(s):** Dr. Sabine Banniza, University of Saskatchewan	Saskatchewan Pulse Growers ($290,000)	March 31, 2018
Integrating Genetic and Genomic Resources for Lentil Improvement	Dr. Kirstin Bett, University of Saskatchewan **Co-investigator(s):** Dr. Bert Vandenberg, University of Saskatchewan	Saskatchewan Pulse Growers ($341,100), Agriculture Development Fund	March 31, 2017

PROJECT TITLE	INVESTIGATORS	FUNDERS	END DATE
Integration of *Aphanomyces* Resistance Screening into Rapid Generation Technology of Lentil and Pea	Dr. Sabine Banniza, University of Saskatchewan **Co-investigator(s):** Dr. Bert Vandenberg, Dr. Tom Warkentin, University of Saskatchewan	Saskatchewan Pulse Growers ($483,506)	April 30, 2018
Management of Volunteer Glyphosate-Resistant Canola in Glyphosate-Resistant Soybean Crops	Dr. Chris Willenborg, University of Saskatchewan **Co-investigator(s):** Rob Guldon, University of Manitoba, Eric Johnson, University of Saskatchewan, Bill May, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($93,015), Agriculture Development Fund, Western Grains Research Foundation	March 31, 2017
Marker-Assisted Introgression of Useful New Diversity into the Pea Genome for Rapid Cultivar Improvement	Dr. Tom Warkentin, University of Saskatchewan **Co-investigator(s):** Dr. Bunyamin Tar'an, Kishore Gali, University of Saskatchewan	Saskatchewan Pulse Growers ($175,880), Agriculture Development Fund, Western Grains Research Foundation	December 1, 2018
Marker-Assisted Selection for *Aphanomyces* Resistance in Pea for Rapid Development of Adapted Pea Varieties With Improved *Aphanomyces* Resistance	Dr. Sabine Banniza, University of Saskatchewan **Co-investigator(s):** Dr. Tom Warkentin, Kishore Gali, University of Saskatchewan	Saskatchewan Pulse Growers ($308,360)	March 31, 2019
Optimum Seeding Rate, Row Spacing, and Disease Management in Faba Bean Varieties	Dr. Steven Shirtliffe, University of Saskatchewan **Co-investigator(s):** Dr. Sabine Banniza, University of Saskatchewan	Saskatchewan Pulse Growers ($449,591)	March 31, 2018
Pea Root Rot: Distribution, Genetic Variability, Resistance, and Management (Develop and Assess Molecular Diagnostic Procedures for the Rapid, Specific, and Sensitive Detection of Root Rot Pathogens in Symptomatic Field Pea Roots)	Dr. Bruce Gossen, Agriculture and Agri-Food Canada **Co-investigator(s):** Debra L. McLaren, Agriculture and Agri-Food Canada, Dr. Stephen Strelkov, University of Alberta, Dr. Robert Conner, Dr. Syama Chatterton, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($109,970), Agriculture and Agri-Food Canada, Manitoba Pulse and Soybean Growers	March 31, 2018
Pulse Crop Advancement Agreement	Dr. Bert Vandenberg, Dr. Tom Warkentin, Dr. Kirstin Bett, Dr. Bunyamin Tar'an, Dr. Sabine Banniza, University of Saskatchewan	Saskatchewan Pulse Growers ($22,617,300)	September 30, 2020
Pulse Crop Regional Trials in Saskatchewan	Dr. Tom Warkentin, University of Saskatchewan **Co-investigator(s):** Dr. Bert Vandenberg, Dr. Bunyamin Tar'an, Dr. Kirstin Bett, University of Saskatchewan	Saskatchewan Pulse Growers ($1,871,494)	December 31, 2020
Reducing Weed Seed Production in Herbicide Resistant Weeds with Pre-Harvest Herbicide Application	Dr. Steve Shirtliffe, University of Saskatchewan **Co-investigator(s):** Lena Syrovy, University of Saskatchewan	Saskatchewan Pulse Growers ($104,650), Agriculture Development Fund, Western Grains Research Foundation	March 31, 2018
Toward Next Generation Chickpea Breeding: Resequencing Diverse Chickpea Accessions	Dr. Bunyamin Tar'an, University of Saskatchewan **Co-investigator(s):** Dr. Rajeev Varshney, International Crops Research Institute for Semi Arid Tropics	Saskatchewan Pulse Growers ($590,488)	March 31, 2018
Towards Generating Multiple-Fungal Disease Resistance in Lentil — Can We Score a Hat Trick?	Dr. Sabine Banniza, University of Saskatchewan **Co-investigator(s):** V. Bhadauria, Dr. Kirstin Bett, Dr. Bert Vandenberg, University of Saskatchewan	Saskatchewan Pulse Growers ($297,820), Agriculture Development Fund, Natural Sciences and Engineering Research Council	February 28, 2019
Western Canada Short Season Soybean Regional Variety Trials	Bill May, Agriculture and Agri-Food Canada Indian Head, Karen Strukoff, Agriculture and Agri-Food Canada Melfort, Greg Ford, Agriculture and Agri-Food Canada Scott, Lana Shaw, South East Research Foundation, Garry Hnatowich, Irrigation Crop Diversification Corporation, Jaret Homer, Stacy Waggenhofer, Dr. Tom Warkentin, University of Saskatchewan	Saskatchewan Pulse Growers ($82,836)	November 15, 2017

02

Soybeans are an up-and-coming crop for Saskatchewan growers. SPG-funded research is looking at developing varieties suited to local growing conditions, and also at agronomic practices to best grow the crop in Saskatchewan.

DEVELOPING MORE OPTIONS

How research is supporting the development of faba beans and soybeans as new crop options for Saskatchewan

02 DEVELOPING MORE OPTIONS

There are two up-and-coming pulse crops in Saskatchewan that are particularly noteworthy right now.

Faba beans are a great option for growers in the northeast of the province, who have had trouble with their pea crops due to wet conditions, says Saskatchewan Pulse Growers' (SPG) Agronomy Manager Sherrilyn Phelps.

"The nice thing with faba beans is that they are resistant to *Aphanomyces* root rot and more tolerant to wetter conditions, so they are a good fit for areas that have had trouble growing peas," she says.

"Growers are recognizing the value of having a pulse in rotation and they are looking for pulse options, but we just have not had great options until faba beans came along."

Faba beans are also exciting due to their nitrogen fixing capability. They are the highest nitrogen fixing grain crop, with the ability to fix about 70–90 per cent of their nitrogen needs, Phelps says.

"This is huge considering that faba bean yields can also be quite phenomenal. Under the right conditions, we have seen yields of over 100 bushels an acre, which leads to a lot of nitrogen fixation. You also see advantages the following year in terms of nitrogen and non-nitrogen benefits."

Soybeans are also promising for Saskatchewan, in that they can be a relatively easy crop to grow, are suited to wetter conditions, and markets are well established, Phelps says.

But these two crops face some distinct challenges for growth in Saskatchewan, which SPG is aiming to address.

Soybeans

One of the major challenges for soybeans is the short growing season in Saskatchewan. For soybean varieties to be successful in Saskatchewan's climate, they must be well adapted to long days, low night temperatures, and a short season.

"The biggest challenge with soybeans for Saskatchewan would be getting them to mature under our conditions," says Dr. Tom Warkentin, Professor with Department of Plant Sciences and Plant Breeder with the Crop Development Centre at the University of Saskatchewan. "It is just a question of, 'Is there going to be enough season for them to mature?'"

Warkentin is currently working on a project that aims to develop soybean varieties suited to grow in Saskatchewan's conditions.

He has been testing germplasm developed by Dr. Elroy Cober, a Research Scientist with Agriculture and Agri-Food Canada who developed soybean populations in Ottawa using early maturing parents, and sending them to Saskatchewan and Manitoba to be tested locally.

"I have been making selections from these populations for the last few years and then advancing the good ones and testing them," Warkentin says. "We have material now that looks quite promising in terms of earliness and yield. I do not have a variety to talk about yet but we think there is pretty good promise."

Another challenge when it comes to growing soybeans in Saskatchewan is weed control, says Dr. Chris Willenborg, a Researcher and Assistant Professor in the U of S's Department of Plant Sciences.

"Soybeans are not a very competitive crop, which is one of the major reasons why they were selected as a crop in need of herbicide-resistance traits," he says. "Weed control was made easier by these systems, but with resistance having now evolved, weed control is becoming more challenging in soybean."

Adding to the problem is that Western Canada produces a lot of canola, which can be a major challenge to control in soybean crops.

"Volunteer canola can emerge throughout the growing season, and timing of emergence has an impact on weed control. Moreover, if the canola

Faba bean production has seen a lot of interest in Saskatchewan in the last few years. SPG-funded research is looking into new and novel ways faba beans can be processed and used as a food ingredient, to help develop markets for this crop.

was glyphosate resistant, the volunteers will not be controlled in glyphosate-resistant soybean without additional measures."

Willenborg is currently wrapping up research aimed to help manage volunteer glyphosate-resistant canola in glyphosate-resistant soybean crops. Overall the research found that the best control method is a combination of pre- and post-emergence treatments, in other words, layering herbicides using a combination of products applied at different times of the year. The best herbicide layering combinations from Willenborg's research were either Express®/Basagran®, Heat®/Viper®, or Express®/Viper® as pre-/post-emergence applications.

The solution for weed control in soybeans is not only herbicides, Willenborg says. Another study he was involved in examined impact of seeding rate and seeding date on volunteer canola management and found that early seeding generally improved the competitive ability of soybeans, but did not always result in higher yields.

"The optimal seeding date to best manage volunteer canola appeared to be the third and fourth week of May," he says.

The same study also concluded that the best seeding rate for soybeans to provide some competition to the volunteer canola ranged 44–57 plants per metre squared (m^2). This seeding rate is just slightly higher than the current recommended seeding rate of 40–45 plants/m^2.

"Interestingly, we found that with a volunteer canola population of 30–40 plants/m^2, even the highest seeding rate of 160 plants/m^2 was still producing increases in yield," he says.

This means that, in situations where soybeans are competing with weeds, there is value in increasing soybean seeding rates, but only up to a certain point, he says. "Increasing seeding rates to target 60 plants/m^2 really only paid when soybean prices were high."

Overall, Willenborg says that the best approach to weed management does not involve just one or two methods — a more integrated approach is always the best solution.

This is the focus of a research project he is currently working on, which aims to determine how we can better manage herbicide-resistant weeds in pulse crops and use integrated solutions to improve control and reduce costs for growers. This research will wrap up in 2021.

FABA BEANS DO IN FACT HAVE A LOT OF NITROGEN IN THE ABOVE-GROUND PLANT MATERIAL AND A HUGE PROPORTION OF THAT NITROGEN IS CONTAINED IN THE GRAIN.

Nutrient Benefits of Pulses

It is well known that pulses contribute to soil health, but many researchers are looking to delve into this issue more deeply.

Dr. Jeff Schoenau, Professional Agrologist and a Professor in the U of S Department of Soil Science, is one of these researchers.

He is currently wrapping up a research project, done in collaboration with Dr. Tom Warkentin, which compared nutrient uptake and content of short-season soybeans to peas and lentils grown in Saskatchewan. The research also looked at how the residues of these crops contribute to the nutrition and yield of subsequently grown wheat and canola crops.

Dr. Chris Willenborg is wrapping up research that would help manage volunteer glyphosate-resistant canola in soybean crops.

The trials were carried out across four sites in the Black and Dark Brown soils zones in Saskatchewan, using three modern varieties of each of the crops.

The results showed a promise for soybean production in Saskatchewan, says Schoenau.

First, while peas tended to be the highest yielders, soybeans were not too far behind. They also had similar rates of nutrient uptake as the other crops, and proved to be good nitrogen fixers.

"The proportion of nitrogen derived from the air through biological nitrogen fixation by the *Rhizobium* in the nodules was similar to or even a little bit higher than what we saw for the other pulse crops, and I think that we achieved that because we double inoculated the soybean crops," he says.

"That is important for soybeans because if soybeans have not been grown before and an inoculant is added, there is very little *Rhizobium* of the correct species to carry out symbiotic nitrogen fixation with soybean in our prairie soils."

They also found that soybeans had a higher concentration of phosphorus and potassium in the grain compared to peas, according to Schoenau.

"The nutrient export potential through crop removal tended to be greater for soybeans compared to the other two pulses grown under the same conditions. That is something to be aware of when soybeans are grown over a number of cycles of a rotation — there is a potential for greater depletion of soil phosphorus and potassium with soybeans."

They did not observe any large differences amongst the different pulse crops in terms of releasing nutrients to the subsequently grown crop or on yields of the subsequent crops in their three-year study.

"We observed similar short-term effects on yield and nutrients in the following crops, which suggests that in the short-term, nutrient requirements for wheat and canola following soybeans are not that much different than what we would expect for the other pulse crops we evaluated," Schoenau says.

Other ongoing SPG-funded research is focused on establishing best agronomic practices around soybean production, in the areas of phosphorus management, irrigation, and nitrogen management.

Faba Beans

There has been a lot of recent interest in faba beans as an alternative to other pulse crops. The crop offers many benefits such as a high yield potential, and large amounts of nitrogen fixation. But not a lot is known about the nutrient requirements of modern faba bean varieties grown under Saskatchewan conditions.

To address this knowledge gap, Schoenau is currently conducting field research in collaboration with Dr. Bert Vandenberg of the Crop Development Centre that ultimately aims to provide Saskatchewan growers with more information on the amounts of plant nutrients required and removed by faba beans in rotation, and to help growers make better decisions around fertilizer use in rotations containing faba beans.

Although they just completed the first field season of the study, there are a couple of early observations.

"Faba beans do in fact have a lot of nitrogen in the above-ground plant material, and a huge proportion of that nitrogen is contained in the grain," Schoenau says.

02 DEVELOPING MORE OPTIONS

They also found that faba beans have a very high phosphorus requirement, which is associated with the high yield potential of this crop.

"Again, like nitrogen, a very large proportion of the phosphorus is in the grain, which is removed in harvest, and there actually is not a lot left behind in the straw. That is a bit different than what we saw for other pulse crops that we evaluated in our other study," says Schoenau.

The study is currently heading into its second season of field trials.

Addressing Agronomic Challenges

In terms of agronomy, there are several challenges to growing faba beans in Saskatchewan.

Dr. Diane Knight, a Professor in the U of S's Department of Soil Science and Saskatchewan Ministry of Agriculture Strategic Research Chair, began addressing some of these challenges when she first began her SPG-funded faba bean research in 2013.

The research project she led explored options for a commercial inoculant for faba beans.

She began by accessing several different collections of *Rhizobium*, some locally sourced and some from the United States, and screening them for their ability to nodulate and fix nitrogen with two faba bean varieties, one large-seeded and one small-seeded. From there, she was able to begin narrowing down the *Rhizobium* options until there were only two strains remaining.

"One of the cool things was that the different cultivars of faba beans — small and large-seeded — actually worked the best with different *Rhizobium* strains, so we were able to pick one that was good for the small-seeded and one that was good for the large-seeded," Knight says. This was an important lesson learned, she says.

"People tend to think that all crops are the same, irrespective of what the cultivar or genetic line is, but this gave us some evidence that this is not really true. As we are breeding and changing plant varieties, maybe we need to be looking at pairing up the more effective *Rhizobium* with those different lines."

Now Knight has progressed to the second phase of this research, which involves taking her findings out into the field for further testing. Last year was the first year of the testing, so it is too soon for results just yet, but Knight feels that the research will yield results that will improve market options for all Saskatchewan-grown crops.

"Increasing the nitrogen-use efficiency of a production system by including efficient nitrogen-fixing crops like faba beans should increase the marketability of all Saskatchewan grown crops on a global scale," she says.

Several other SPG-funded research projects are also aiming to help nurture the production of faba beans in Saskatchewan. Some of these projects are looking to determine best agronomic practices around growing the crop, such as optimal seeding rates and dates, disease management practices, irrigation treatments, and inoculation options. Another project aims to learn more about chocolate spot, a disease that affects faba bean crops in Saskatchewan, and will likely continue to grow in importance as growers produce more and more of this crop.

Developing Markets

One of the main challenges with faba beans is on the marketing side, says Phelps.

"The big challenge for faba beans is understanding where the potential markets are and how best to access those," she says.

For this reason, SPG invested in market research looking at opportunities for Canadian faba beans in world markets. The study aimed to better understand production and market demand for the crop, in order to determine where there is opportunity for growth, and opportunities for Saskatchewan to meet that growth.

The results of this study have helped SPG narrow down its strategy to help develop emerging markets for faba beans.

For example, the results showed that while the production of faba beans has grown impressively over the last three years, the market for domestic food use does not offer the greatest opportunity for development.

Other potential markets for the crop hold greater opportunity. One of these is the fractionation market, which is still in its infancy. In order to help develop this potential market, SPG is currently funding research in

this area, such as the project being led by Dr. Shannon Hood-Niefer, Scientist and the Vice President of Innovation and Technology at the Saskatoon Food Industry Development Centre.

"I believe faba bean is the next big pulse crop, from a food processing point of view," she says. "It is bland in flavour, higher in protein, and has a neutral colour, so it is easier to work with."

There is currently a lot of interest in the crop from the commercial food industry, she says.

"Some of the larger multinationals we are working with are very interested in faba beans. We are doing a lot of new food product development dealing with higher protein levels."

Dr. Hood-Niefer is currently leading a three-year research project that aims to help food companies better understand how and why to include faba beans in their products.

The research began by analyzing 10 different varieties of faba beans, and they found that protein content ranged from 25.2–28.9 per cent. This is the big sell for food companies, Dr. Hood-Niefer says, as consumers are currently looking for foods with higher amounts of protein.

"Say you are making bread and you only have 20–30 per cent room in your formulation to do a supplementation with a pulse product. If you were to choose a faba bean flour instead of a pea flour you would have higher protein content," she says.

"Food manufacturers are really looking at those protein numbers. It makes it easier to get to a level where you could potentially make a protein content claim."

Now the research is exploring what percentage of faba bean ingredient can be added to food products without affecting the taste or functionality. Another important element of the research is minimizing the risks involved with the vicine and convicine levels in faba beans. These compounds can cause an acute, negative reaction in some populations of people who suffer from a pre-existing condition. The prevalence of this pre-existing condition has not been studied in North American populations. To help with this, there is a toxicologist involved in the project to help determine how processing faba bean impacts its vicine and convicine levels.

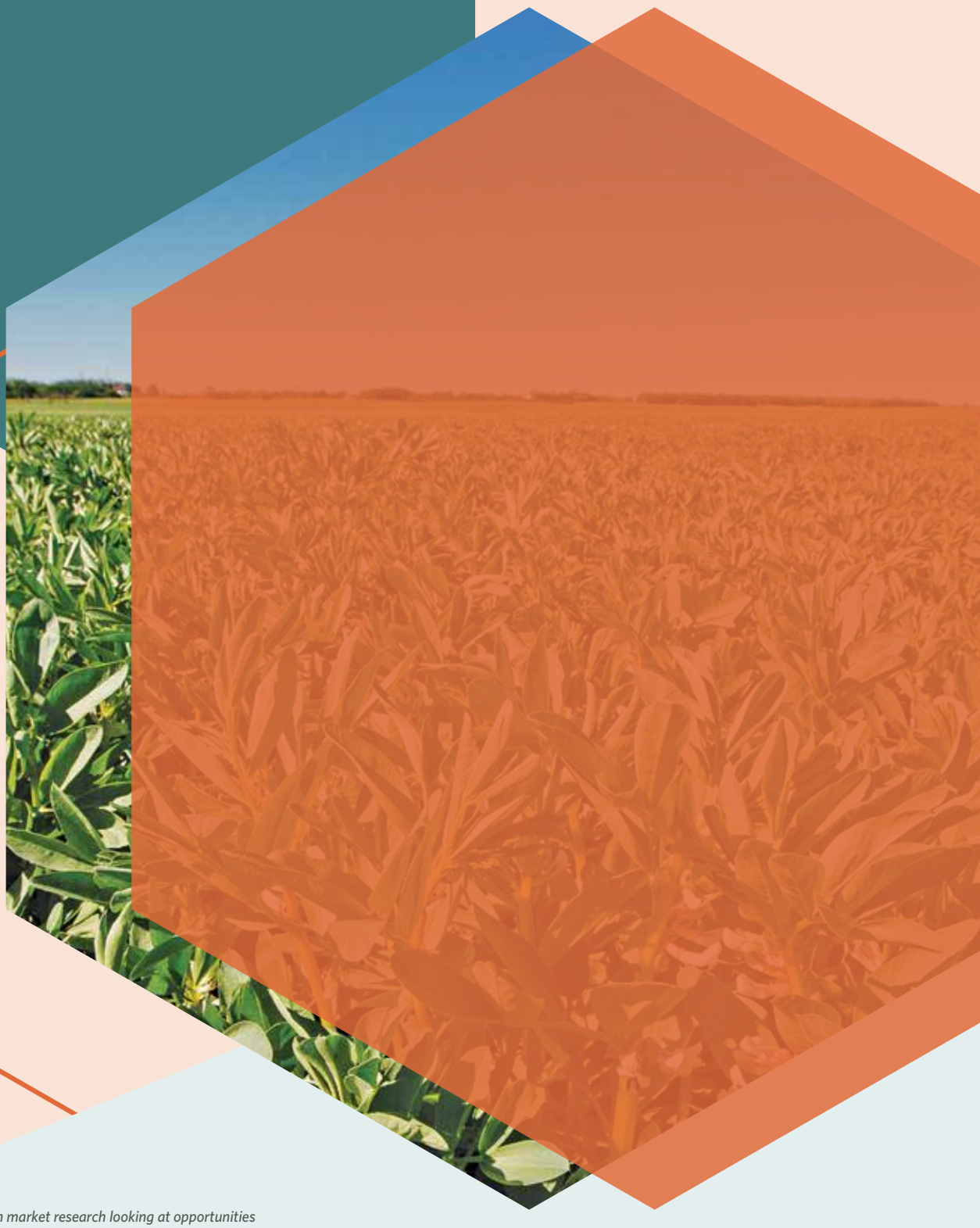
The next phase of the research will involve making actual food products, which will then be analyzed for functionality and taste, and will undergo toxicology testing.

The research is set to wrap up next year and Dr. Hood-Niefer hopes to then have concrete results to take to food companies.

"I think once we get over the hurdle of vicine/convicine, we will see faba beans take off as one of the pulses that is easy to work with."

02 DEVELOPING MORE OPTIONS: PROJECTS FEATURED

PROJECT TITLE	INVESTIGATORS	FUNDERS	END DATE
Adaptation and Establishment of Soybean Glycine Max Under No-Till in South Saskatchewan	Chris Holzapfel, Indian Head Agricultural Research Foundation **Co-investigator(s):** Bryan Nybo, Wheatland Conservation Area	Saskatchewan Pulse Growers ($67,625), Agriculture and Agri-Food Canada	March 31, 2018
Developing Nitrogen Management Recommendations for Soybean Production in Saskatchewan	Chris Holzapfel, Indian Head Agricultural Research Foundation **Co-investigator(s):** Garry Hnatowich, Irrigation Crop Diversification Corporation, Stewart Brandt, Northeast Agriculture Research Foundation, Christiane Catellier, Indian Head Agricultural Research Foundation	Saskatchewan Pulse Growers ($123,732)	March 31, 2018
Developing Phosphorus Management Recommendations for Soybean Production in Saskatchewan	Chris Holzapfel, Indian Head Agricultural Research Foundation **Co-investigator(s):** Garry Hnatowich, Irrigation Crop Diversification Corporation, Stewart Brandt, Northeast Agriculture Research Foundation, Jessica Weber, Western Applied Research Corporation, Gazali Issah, University of Saskatchewan, Christiane Catellier, Indian Head Agricultural Research Foundation	Saskatchewan Pulse Growers ($106,740)	March 31, 2018
Development of Adapted High Yielding Faba Bean for Saskatchewan	Dr. Bunyamin Tar'an, University of Saskatchewan **Co-investigator(s):** Dr. Bert Vandenberg, Hamid Khazaei, University of Saskatchewan	Saskatchewan Pulse Growers ($675,257)	March 31, 2020
Development of a *Rhizobium* Inoculant for Faba Bean	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($174,996)	June 30, 2018
Epidemiology of Chocolate Spot of Faba Bean	Dr. Syama Chatterton, Agriculture and Agri-Food Canada **Co-investigator(s):** Robyne Bowness, Alberta Agriculture and Forestry, Dr. Sabine Banniza, University of Saskatchewan	Saskatchewan Pulse Growers ($121,296), Agriculture Development Fund	March 31, 2021
Evaluating Inoculant Options for Faba Beans	Garry Hnatowich, Irrigation Crop Diversification Corporation	Saskatchewan Pulse Growers ($305,780)	March 31, 2018
Evaluating Rhizobia Strains for Nitrogen Fixation in Faba	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($88,906), Agriculture Development Fund	June 30, 2016
Improved Iron Chelates for Treatment of Iron Chlorosis in Saskatchewan Pulse and Fruit Crops	Matthew Paige, University of Saskatchewan **Co-investigator(s):** Dr. Tom Warkentin, University of Saskatchewan	Saskatchewan Pulse Growers ($15,333), Agriculture Development Fund	September 1, 2017
Management of Volunteer Glyphosate Resistant Canola in Glyphosate Resistant Soybean Crops	Dr. Chris Willenborg, University of Saskatchewan **Co-investigator(s):** Rob Guldon, University of Manitoba, Eric Johnson, University of Saskatchewan, Bill May, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($93,015), Agriculture Development Fund, Western Grains Research Foundation	March 31, 2017
Moisture Management Effects on Soybean and Faba Bean in Saskatchewan	Dr. Dale Tomasiewicz, Canada-Manitoba Crop Diversification Centre **Co-investigator(s):** Garry Hnatowich, Irrigation Crop Diversification Corporation	Saskatchewan Pulse Growers ($79,890)	March 31, 2018
Nutrient Content and Release From Soybean Residues in Comparison to Other Pulse Crops in Saskatchewan	Dr. Jeff Schoenau, University of Saskatchewan **Co-investigator(s):** Jing Xie, University of Saskatchewan	Saskatchewan Pulse Growers ($61,835), Agriculture Development Fund, Western Grains Research Foundation	April 15, 2017
Nutrient Uptake and Nitrogen Fixation by Faba Bean in Saskatchewan Soils	Dr. Jeff Schoenau, University of Saskatchewan	Saskatchewan Pulse Growers ($37,519), Agriculture Development Fund	November 1, 2018
Optimum Seeding Rate, Row Spacing, and Disease Management in Faba Bean Varieties	Dr. Steven Shirtliffe, University of Saskatchewan **Co-investigator(s):** Dr. Sabine Banniza, University of Saskatchewan	Saskatchewan Pulse Growers ($449,591)	March 31, 2018
Very Short Season Herbicide Tolerant Soybean Development	Dr. Elroy Cober, Agriculture and Agri-Food Canada **Co-investigator(s):** Dr. Tom Warkentin, University of Saskatchewan	Saskatchewan Pulse Growers ($102,500), Canadian Field Crop Research Alliance, Agriculture and Agri-Food Canada	March 31, 2018



SPG has invested in market research looking at opportunities for Canadian faba beans in world markets aimed at understanding production and market demand for the crop.

03

Two ongoing SPG-funded research projects are aiming to help growers understand what the optimal tillage practices are for increasing crop quality and yield and maximizing economic returns.

UPHOLDING PULSE SUSTAINABILITY

Research demonstrates there is still a lot to learn about the link between pulses and sustainability

03 UPHOLDING PULSE SUSTAINABILITY

Growers already know that pulses have a lot to offer in terms of environmental benefits for their farm. Because they fix their own nitrogen and increase the diversity of soil microbes, pulse crops increase the health of the soil, which can also help increase the quality of subsequent crops. They also have a lower water and carbon footprint than other protein-rich sources. This is extremely important at a time when world demand for plant-based protein is rapidly increasing.

So what is left to learn about pulses and sustainability?

Well, actually a lot, says Dr. Lisette Mascarenhas, Director of Research and Development at Saskatchewan Pulse Growers (SPG).

Growers are aware of the benefits of growing pulses, but it is important to drill down deeper, so that we gain a greater understanding of why and how pulses benefit on-farm sustainability and how they can continue to do so in the long term.

"It has been known for a long time that pulses fix nitrogen and therefore the requirement for nitrogen fertilizer is lower in pulses than for other crops," Dr. Mascarenhas says.

"There has also been research in the past that showed pulses can actually improve the interactions between organisms that generate increased diversity in the soil, which means a healthier environment. We also know that pulses like lentils and chickpeas can tolerate drier conditions reducing the need for a lot of water, so collectively the overall message is that pulses are good for the environment."

"Now the focus is providing information, through studies over time, for how including pulses in various rotations are beneficial. We know pulses are good for the soil but we want to know how, exactly."

These themes fall under SPG's research priorities of increasing the production of pulses, and removing constraints to production in Saskatchewan. SPG has also partnered with other agencies that are committed to research in the area of sustainability, such as Agriculture and Agri-Food Canada, to leverage funding for projects that are important to Saskatchewan's pulse industry.

Through several ongoing research projects in this area, it is apparent that we are still learning about the important role that pulses play in on-farm sustainability.

Nitrogen Fixation and Nitrous Oxide (N_2O) Emissions

Dr. Richard Farrell, an Associate Professor in the University of Saskatchewan's (U of S) Department of Soil Science, has been studying the relationship between pulses and nitrogen for many years, most recently leading a study that aims to clarify the relationship between pulse crops and N_2O emissions.

"There has been concern that pulses, because they fix a lot of nitrogen and return it to the soil, might have a higher nitrogen penalty associated with them," he says. "That was the question going into this research — is that actually true?"

"Right now, all the methodology used to calculate greenhouse gas (GHG) inventory assumes that all forms of nitrogen are the same. Whether ammonium nitrogen fertilizer, cattle manure, or crop residues, the emission factors for fertilizer apply to everything."

Farrell did not believe this was accurate, and his research, which is set to wrap up shortly, set out to prove this. To do so, he created a very controlled environment to measure the cycling of atmospherically fixed nitrogen by lentils, chickpeas, and faba beans, and the contributions of the fixed nitrogen to N_2O emissions, as well as its uptake by a following wheat crop.

"We developed a greenhouse system that allowed us to feed plants in a nitrogen-enriched atmosphere so that any nitrogen that wound up back in the system had to have been fixed by the plants," he says. "This allowed us to look at the four plants side-by-side to see how they performed."

Dr. Diane Knight is interested in learning more about how pulses behave under no-tillage management, especially what happens with the soil microbial community.

03 UPHOLDING PULSE SUSTAINABILITY

During the next phase, the research team grew wheat in the same soils containing the pulse residues, and then tracked the residue-derived nitrogen and N_2O produced.

The following year, the trials were moved out into the fields, growing the same crops and varieties in the same soils. The team then examined the above- and below-ground residues.

UNLIKE RHIZOBIUM, FREE-LIVING BACTERIA DO NOT NEED A LEGUME PLANT TO FIX NITROGEN. THESE ORGANISMS CAN BE PLENTIFUL IN NATIVE PRAIRIES.

Although they are still pulling the data together, Farrell says there are some early results.

"What we are seeing is that the overwhelming majority of the emissions come from fertilizer," he says. "When you add fertilizer in, 90 per cent or so of total emission is fertilizer induced. It is clear that pulse residues are not the equivalent of fertilizer."

It is also clear that the below-ground residues contribute more than the above-ground residues, he says, and that the soil contributes only minor amounts.

"The data are really pointing to the fact that below-ground nitrogen is really important and that we really do not have a good way of accounting for it," he says.

Overall, these early results mean the concerns about pulses and N_2O emissions have been overplayed, Farrell says.

"The preliminary data suggest that the emission factor for residues will be lower than emission factors for fertilizer," he says.

"We think because of all this below-ground nitrogen, we are getting a bigger nitrogen credit from pulses than we are giving them credit for now. They also have a smaller contribution to N_2O emissions than people thought they would."

Another interesting finding of this research had to do with faba beans, says Dr. Diane Knight, a co-investigator on the project and a Professor in the U of S Department of Soil Science.

"Faba beans are thought to be one of the best nitrogen fixing crops, so growers are quite interested in it for rotations," she says.

In field trials, they saw nitrogen fixation rates for faba beans of around 70–80 per cent, the highest amount of all the crops observed.

Knight is also working on a different project that involves exploring the potential of faba beans to cut down on the need for fertilizer requirements. Specifically, the study aimed to develop a collection of *Rhizobium* species isolated from different wild legume species, and test their effectiveness in nodulating the major pulse crops grown in Saskatchewan.

"We wanted to develop a collection of rhizobia that are from cold climates so that with climate change we will have access to a range of different rhizobia that may be better than what we have right now in commercial inoculant."

To facilitate this, Dr. Knight and her team collected many species of native legumes from around the province, as well as some from the Yukon.

"We are looking at the wild legumes to see if we can find *Rhizobium* that work really well but mostly because they are going to be adapted to the climate here. The ones from the Yukon are quite special —

they are able to be quite metabolically active, especially in these cold climates."

Once they had developed their collection, they then isolated and purified the *Rhizobium* from the native legume nodules.

"We were basically identifying what plants have what *Rhizobium* in them, screening them against peas and lentils, and documenting whether or not they can nodulate and fix nitrogen in these different crop plants."

At this point in the research they have sent the DNA off for sequencing in order to identify the actual species of *Rhizobium* they are dealing with. Later this year, Knight hopes to be one step closer to having a resource available that is better adapted to the climatic extremes.

Optimal Tillage Practices

Another ongoing question in Saskatchewan agriculture is: What are the optimum tillage practices for increasing crop quality and yield, and maximizing economic returns?

Two ongoing studies funded by SPG are looking to help answer this question.

Knight is currently looking at the effects of a long-term, no-tillage system on the nitrogen balance in the soil. Previous studies aimed at calculating nitrogen balances have taken a larger, whole-system view, instead of a farm-by-farm view, Knight says.

"When looking at the whole system, researchers almost always come up with more nitrogen coming into the system than being lost — the nitrogen budgets do not balance."

Knight's project is examining if the gain in nitrogen is because of free-living nitrogen fixing organisms in the soil. Unlike *Rhizobium*, free-living bacteria do not need a legume plant to fix nitrogen. These organisms are plentiful in native prairies.

Knight and her team suspect that as soils are managed with no tillage, the soil microbial populations begin to convert back to those populations similar to native prairies. The higher nitrogen inputs compared to outputs may be a result of increased numbers of free-living nitrogen fixing organisms due to the conversion to no tillage.

To measure this, Dr. Knight and her team have looked at growers' fields that have been under no-tillage management for different lengths of time, some up to 25 years, to see if there was an increase in free-living nitrogen fixation. They also examined some

Dr. Diane Knight is working on a research project that explores the potential of faba beans to cut down on the need for fertilizer requirements.

native prairie sites, in which all the nitrogen comes from either free-living nitrogen fixation or wild legumes, to use as their baseline example of how much free-living nitrogen fixation might be present in the soils.

At this point it is too early to have any concrete results, but Knight feels that once the study wraps up later this year, there will be some practical takeaways that will help pulse growers adjust their fertilizer management and potentially cut back on their added nitrogen levels.

Another ongoing study in this area is looking at the effects of vertical tillage on soil structure and crop yields in southern Saskatchewan.

The project began in 2015 and is led by Dr. Bing Si, a Researcher and Professor in the U of S Department of Soil Science, with expertise in soil physics. The study compares the effects of different pre-seeding tillage treatments, such as vertical and conventional tillage, raking and burning, as well as direct seeding into flax stubble.

The crops involved in the research include wheat and peas, says Dr. Jeff Schoenau, Professor in the Department of Soil Science, who is also one of the researchers on the project.

"In terms of the different tillage treatment effects we compared, we really did not see any significant differences among the treatments on yield of wheat grown in the first year," he says, adding that it is still early in the study.

"For effects on soil physical properties, one effect we did see was that vertical tillage tended to result in slightly lower air permeability, which is the ability of air to enter the soil, than the disk treatment. The action of the rolling basket might have increased the proportion of fine pores in the soil," Schoenau says.

This research is set to wrap up in 2018, after two more field seasons are completed.

Water Footprints

One issue that has become important for agriculture recently is that of water footprints, in other words, how much water is required to produce specific quantities of each crop.

This issue is only going to increase in importance in coming years, says Si.

In order to get ahead of the curve on the issue of water footprints for Saskatchewan agriculture products, Si is currently facilitating research that will quantify and compare the water value for Saskatchewan-grown canola, wheat, and pulses.

The research will also test whether or not pulses grown in a rotation have the ability to improve the water footprint for the overall rotation, as nitrogen production requires water and pulses reduce overall nitrogen input into the soil.

The research is only about halfway complete, but Si is optimistic that the results will yield good news for the pulse industry.

"We expect that when you consider everything in a comprehensive way, you would have at least a reduction of water footprint per unit of grain yield," he says.

He also expects the research will offer concrete evidence that pulses offer protein at a lower water cost.

"Consumers are interested in protein and pulses have a high protein content, so if our purpose is to produce a large amount of protein per unit of water consumption, then we can show that pulse crops would be the way to go," he says.

Si's research will wrap up in late 2017.

Rotations

It is generally known that it is good to include pulses in your crop rotation, but ongoing research is drilling down into deeper questions, such as exactly which crops are best to grow in sequence.

Knight is involved in some preliminary work looking to identify soil characteristics that impact biological nitrogen fixation in pea and lentil crops grown after canola.

"One of the things I do in most projects I am involved in with rotations is measure nitrogen fixation," she says. "What we found in Swift Current is when we grew peas or lentils right after canola, it did not fix

nitrogen to the same degree as if we grew it right after wheat in a rotation."

Other areas of the province did not seem to show the same problem, Knight says, but Swift Current did so consistently.

"There seems to be some inhibitory thing happening with the canola affecting the pea crop," she says.

Although it is very early in the research, Dr. Knight has a theory as to why, and it involves the level of organic matter in the soil.

"Soil organic matter often acts as a buffer against bad things happening. In the Brown soil zone, where Swift Current lies, there is not as much soil organic matter as in other soil zones."

This research is set to wrap up in 2020, and Knight hopes to have more information at that point to help pulse growers in the southern part of the province make better rotation decisions.

Other SPG-funded research is looking at developing more systematic approaches to minimizing the negative environmental impacts of crop production, while also increasing crop yield and overall farm economics.

One of Dr. Jeff Schoenau's research sites in Rosthern, SK. This research compared the nutrient content and uptake of pea and lentil crops, and also looked at how the residues of these crops contributed to the nutrition and yield of subsequently grown wheat and canola crops.

03 UPHOLDING PULSE SUSTAINABILITY: PROJECTS FEATURED

PROJECT TITLE	INVESTIGATORS	FUNDERS	END DATE
Canola Grown Before a Pulse Crop: Is biological nitrogen fixation affected?	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($205,735)	April 30, 2020
Crop Water Footprints and Virtual Water Flows: A comprehensive evaluation of crop water use in Saskatchewan	Dr. Bing Si, University of Saskatchewan **Co-investigator(s):** Dr. Wei Hu, Dr. Jeff Schoenau, University of Saskatchewan	Saskatchewan Pulse Growers $115,000	December 31, 2017
Development of a *Rhizobium* Inoculant for Faba Bean	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($174,996)	June 30, 2018
Direct Assessment of the Release of Fixed Nitrogen in the Rhizosphere of Pea, Lentil, Chickpea, and Faba Bean	Dr. Richard Farrell, University of Saskatchewan **Co-Investigator(s):** Dr. Diane Knight, University of Saskatchewan, Dr. Reynald Lemke, Agriculture and Agri-Food Canada, Shwetha Liyanage, University of Saskatchewan	Saskatchewan Pulse Growers ($65,786), Agriculture Development Fund, Western Grains Research Foundation	March 1, 2017
Effects of Vertical Tillage on Soil Structure and Crop Yields in Southern Saskatchewan	Dr. Bing Si, University of Saskatchewan **Co-investigator(s):** Dr. Wei Hu, Dr. Jeff Schoenau, University of Saskatchewan	Saskatchewan Pulse Growers ($49,766), Agriculture Development Fund, Saskatchewan Wheat Development Commission, Western Grains Research Foundation	January 31, 2019
Enhanced Saskatchewan Soil Data for Sustainable Land Management	Dr. Angela Bedard-Haughn, University of Saskatchewan **Co-Investigator(s):** Henry de Gooijer, Government of Canada, Dr. Brian McConkey, Agriculture and Agri-Food Canada, Dr. Jeff Schoenau, University of Saskatchewan, Don Campbell, Soil Conservation Council of Canada, Darrel Cerkowniak, Agriculture and Agri-Food Canada, Tim Nerbas, Soil Conservation Council of Canada, Dr. Ken Van Rees, Dr. Darwin Anderson, Dr. Ralph Deters, University of Saskatchewan.	Saskatchewan Pulse Growers ($57,768), Agriculture Development Fund, Saskatchewan Canola Development Commission	January 15, 2018
Enhancing the Long-Term Sustainability of Pulse Cultivation Using System Approaches	Dr. Yantai Gan, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($1,004,036), Agriculture Development Fund	March 31, 2021
Evaluating Inoculant Options for Faba Beans	Garry Hnatowich, Irrigation Crop Diversification Corporation	Saskatchewan Pulse Growers ($305,780)	March 31, 2018
Evaluating Rhizobia Strains for Nitrogen Fixation in Faba Bean	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($88,906), Agriculture Development Fund	June 30, 2016
Has Transition to No-Tillage Resulted in More Free-Living Soil Nitrogen Fixation?	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($114,885), Western Grains Research Foundation	December 31, 2017
Nutrient Content and Release From Soybean Residues in Comparison to Other Pulse Crops in Saskatchewan	Dr. Jeff Schoenau, University of Saskatchewan Co-investigator(s): Jing Xie, University of Saskatchewan	Saskatchewan Pulse Growers ($61,835), Agriculture Development Fund, Western Grains Research Foundation	April 15, 2017
Nutrient Uptake and Nitrogen Fixation by Faba Bean in Saskatchewan Soils	Dr. Jeff Schoenau, University of Saskatchewan	Saskatchewan Pulse Growers ($37,519), Agriculture Development Fund	November 1, 2018
Optimizing the Frequency and Sequence of Annual Pulses in Cropping Systems and Their Impacts on Crop Performance, Biotic and Abiotic Stresses, and Soil Quality Attributes	Dr. Yantai Gan, Dr. Chantal Hamel, Agriculture and Agri-Food Canada **Co-investigator(s):** Dr. Manjula Bandara, Alberta Agriculture and Forestry, Dr. Myriam Fernandez, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($125,099), Agriculture and Agri-Food Canada	March 31, 2018
Quantifying the Contribution of Pulse Crop Residues to Greenhouse Gas Emissions, Nitrogen Nutrition, and the Growth of a Subsequent Wheat Crop: A dual isotope labeling approach	Dr. Richard Farrell, University of Saskatchewan **Co-Investigator(s):** Dr. Diane Knight, University of Saskatchewan, Dr. Reynald Lemke, Agriculture and Agri-Food Canada, Liting Liu, University of Saskatchewan	Saskatchewan Pulse Growers ($368,845), Western Grains Research Foundation, Agriculture Development Fund	November 30, 2018
Responding to Climate Fluctuations: Development of a *Rhizobium* collection	Dr. Diane Knight, University of Saskatchewan	Saskatchewan Pulse Growers ($84,881), Western Grains Research Foundation	April 30, 2017
Transformation and Fate of Seed-Placed Sulfur Fertilizers in Saskatchewan Soils	Dr. Jeff Schoenau, University of Saskatchewan	Saskatchewan Pulse Growers ($30,738), Agriculture Development Fund, Western Grains Research Foundation	March 31, 2016

We already suspect that pulses contribute to soil health, but ongoing SPG-funded research is looking to answer more specific questions, such as how much nutrient content and uptake do different pulse crops produce and what the nutrient requirements are.

04

The feed market presents great opportunities for Saskatchewan-grown faba bean. SPG is currently working on helping to grow this market, while at the same time ensuring there is consistent supply of the crop coming from Saskatchewan.

BUILDING NEW MARKETS

SPG-funded research explores how pulses can help create a healthier world

04 BUILDING NEW MARKETS

One of Saskatchewan Pulse Growers' main priorities is increasing demand for pulse crops.

This is a timely goal, says Dr. Lisette Mascarenhas, Director of Research and Development, as the global interest in pulses is currently on the rise.

"More and more people are looking at pulses with new eyes, whether for socioeconomic, health, or environmental reasons," she says.

According to a report released last year by Lux Research, the global demand for plant-based proteins is set to grow at a rapid pace in coming years, with total protein demand doubling by 2054, to 943.5 million tonnes.

Mascarenhas says that SPG-funded research is preparing us to meet that demand, through a couple of ways.

The first is by exploring the best ways for consumers to consume pulses. The second is by increasing our knowledge around pulse processing and utilization in food, animal feed, and industrial applications.

"This could be post-production, end-use processing research into how to incorporate pulses into as many products as possible," she says.

This is an especially important area right now, according to Mascarenhas, as more and more commercial food companies are looking for novel ways to make their products healthier and more marketable to a consumer base that is increasingly concerned with eating healthier food products. Pulses are a great fit for this market, as they hit many of the health trends today — including that they are high in protein and fibre, and more.

"Companies are interested in looking at how to best complement certain traditional ingredients with pulse ingredients to improve the nutritional profile. For example, companies want to make breads or baked foods containing pulses so that they can use the marketing message that it is higher in protein and fibre, and therefore good for you."

The same trend is ongoing in the pet food market as well, she says, although it is also facing the challenge of trying to find the right balance of pulses to include to make the end product more nutritious, without affecting the taste to a point where it is less appealing to pets.

The second way that SPG is preparing the industry to meet the growing market demand is by supporting health research, which is required to support marketing and health claims for pulses.

"We are moving in the right direction in terms of health research but we are not there yet," Mascarenhas says. "There is still confusion in terms of what forms of pulses you need to consume, and how much for desired outcomes."

"Right now, we are trying to put all the pieces together to see what the gaps are that we need to fill."

SPG is currently funding a variety of research projects that meet the two objectives mentioned above. Here is a look at some of the exciting areas being explored.

Food Ingredients

Pulses offer many benefits as food ingredients, but their taste can often be an obstacle.

One project is currently looking at fixing this, by modifying the production process for protein isolates from peas, lentils, and faba beans to improve the flavour profiles.

Dr. Michael Nickerson, Associate Professor in the University of Saskatchewan's (U of S) Food and Bioproduct Sciences Department, is leading this research.

"As many of us know, flavour compounds present in pulse ingredients create significant challenges for product developers," he says. "We are looking to further our commercial-scale wet process for producing pulse protein isolates. In particular, looking at industrial processing strategies for removing flavour compounds from pulse fractions to produce a blander final protein ingredient."

SPG is focused on finding new and improved uses for pulse crops, in order to increase global demand for the crops.

04 BUILDING NEW MARKETS

This research is important right now, as food companies are very interested in including pulses in their products for a number of reasons, one of which is that they do not have to be labelled as allergens on product labels.

"Consumers want cleaner labels, meaning they want to understand the ingredients within the product, and that the product has no allergen warning," Nickerson says.

One of the more commonly used protein ingredients right now is soya, according to Nickerson, but food manufacturers are looking for alternatives.

Overall, this research will help grow demand for Saskatchewan-grown pulses, Nickerson says.

"Developing pulse protein isolates with speciality functionality will help diversify the vegetable protein ingredient market, creating growth opportunities for secondary processing in the province."

SPG is also funding research through the Canadian International Grains Institute (Cigi) that aims to develop a database of information on how pulses can best be used as ingredients in baked goods, to improve the health and nutrition of the final products. This research is set to wrap up in 2019. Other currently funded research is exploring how pulses may be included as ingredients for meat products in order to improve their nutrition, quality, and value.

Novel Uses

SPG is focused on finding new and improved uses for pulse crops, in order to increase global demand for the crops.

Nickerson is leading one such project that is exploring the use of pulses in a non-typical context. This research explores using pulses to microencapsulate fatty acids in food products.

"Microencapsulation is a technology that entraps or packages sensitive core materials, such as omega-3 fatty acid rich oils from flax or fish," Nickerson says.

"This package is made of protein, which in our case is primarily comprised of lentil protein isolate, along with some other ingredients. Its function is basically to inhibit oxygen from reacting with the oil to cause oxidation, and to allow the ingredient to be easily dispersed within an aqueous food product."

Today, the better performing capsules are made from animal-based proteins but manufacturers are looking for alternatives, says Nickerson. Pulses present a great alternative, as they cost less, are more nutritious, and are non-allergenic.

Also helping drive the demand for alternatives to animal-based protein is the fact that consumer are still leery of animal-derived proteins because of bovine spongiform encephalopathy (BSE).

Nickerson has been working on developing this technology for a decade now. Two of his previous projects in this area were focused on designing the technology. This current project will actually produce the microcapsules and test them in dairy animal feed trials.

"Currently, we are scaling up our process at POS BioSciences, and are aiming to move towards carrying out a dairy-feeding trial to show proof of concept of our technology," he says. "If successful, the higher

PULSES ARE ATTRACTIVE TO INDUSTRY, AS THEY DO NOT REQUIRE ALLERGEN WARNINGS ON PRODUCT LABELS CONTAINING THESE INGREDIENTS.

quality omega-3 rich fluid milk could be used to produce other omega-3 rich products, such as cheeses and yogurts."

The next step will be to find a company to partner with to scale up the product and introduce it into the marketplace.

The project will officially wrap up in 2019 and Nickerson hopes that once everything is complete, the research will launch demand for Saskatchewan-grown pulse ingredients.

Pet Food

We know that pulses are healthy for humans, but one researcher has been working to prove that they are also healthy for our pets.

Dr. Lynn Weber, a Researcher and Professor in the U of S Department of Veterinary Biomedical Sciences, has already proved through previous SPG-funded

According to a report released last year by Lux Research, the global demand for plant-based proteins is set to grow at a rapid pace in coming years, with total protein demand doubling by 2054, to 943.5 million tonnes.

research that including pulse starches in both cat and dog food had a positive effect on the health of the animals, through improved weight control and lowered rates of diabetes.

But the problem she discovered was that the cats involved in the study did not care for the taste of the pulse-based pet foods.

"You could leave them an overflowing bowl of food and they would refuse to eat it for up to five days," she laughs. "That is how much they hated it."

This is why her current research aims to determine if they can improve the taste of the pet food, while at the same time increasing the nutrition. Weber believes that by fermenting the pulse starches before they are used as ingredients, she can achieve both these goals.

The fermentation process, which involves adding nitrogen and yeast to the pulse starch, will yield a more complete, more nutritious protein source, she says.

"Plant proteins are not as complete nutritionally. They are lacking a couple of important amino acids compared to animal protein," she says. "The great thing about yeast is that it makes the whole mixture of amino acids you need, so it makes a complete protein."

Yeast is also known to have a positive prebiotic effect, she says.

"It promotes the growth of good microbes in the gut and/or does something to improve gut health — we do not know exactly how, but it reduces gut inflammation and makes good gut bacteria grow."

Weber expects that the effect on gut health will be especially beneficial to the pets, just as it is believed to be in humans.

"We know from human health it is important to have a healthy gut," she says.

The research is still in early stages of developing the fermented pea starch, but the next steps will involve actually testing the food with cats and dogs, to see if they show a preference for the food containing fermented ingredients. They will also test the health effects of the food on the pets.

The research will wrap up in 2019 and will yield information that will be useful for pet food manufacturers looking to make healthier products.

Human Health Outcomes

There are some exciting opportunities for pea hull fibre on the horizon in North America and Dr. Wendy Dahl, a Researcher and Associate Professor at the University of Florida, is currently exploring them.

This is a great time to be bringing attention to this source of fibre, Dahl says, as new United States (U.S.) Food and Drug Administration (FDA) regulations are about to restrict most of the sources of soluble fibres that are currently being used in food products.

Pea hull fibre is already considered a dietary fibre by the FDA, so it will not be affected by these regulations, according to Dahl.

"This presents a huge advantage over most of the isolated fibres that have dominated the U.S. market for years."

Another major opportunity for pea hull fibre is that it is ideal for partial replacement for wheat flour, because of its characteristics and water-holding capacity.

"It works phenomenally well in baked products like muffins and bread, and those are foods that really need fibre fortification," Dahl says.

Another advantage of pea hull fibre is its ability to act as a laxative and therefore treat people who suffer from constipation more effectively than many of the isolated fibres that are currently on the market.

This is the area of focus for Dahl's current research, which involves testing the health effects of pea hull fibre on three primary target groups.

The first group is healthy older adults, who tend to have more gastrointestinal tract and constipation issues, particularly women.

The second group is children with constipation issues. Because obese children tend to have more

issues with constipation, the study will look at testing whether the negative effects of constipation cause overeating in these children, or if it is the other way around. Previous research led by Dahl also suggested that pea hull fibre was able to suppress food intake in overweight children. Therefore, it will be interesting and important to determine the overall role that pea hull fibre could play in treating childhood obesity.

The third target group for this research is people who suffer from chronic disease linked to lack of fibre and constipation.

"When things stay in our colon for long periods of time, inflammatory substances are produced by bacteria in the colon," Dahl says. "Those are then absorbed in the body and contribute to cardiovascular disease, loss of kidney function, and other risks."

The patients in this portion of the study have chronic kidney disease, and have high levels of these inflammatory substances in their bodies. Dahl believes that pea hull fibre will help to decrease the amount of those substances and improve their overall health.

These studies will officially wrap up next spring, at which time Dahl expects to have some good news about how pea hull fibre can help people who are affected by constipation and related issues. These results will be widely shared through extension activities, she says.

Relatedly, Dahl is also currently working on developing more practical guidelines around how to increase the consumption of pea hull fibre amongst long-term care residents. This type of information is important to include alongside research outcomes, to ensure that findings can be put into practice, she says.

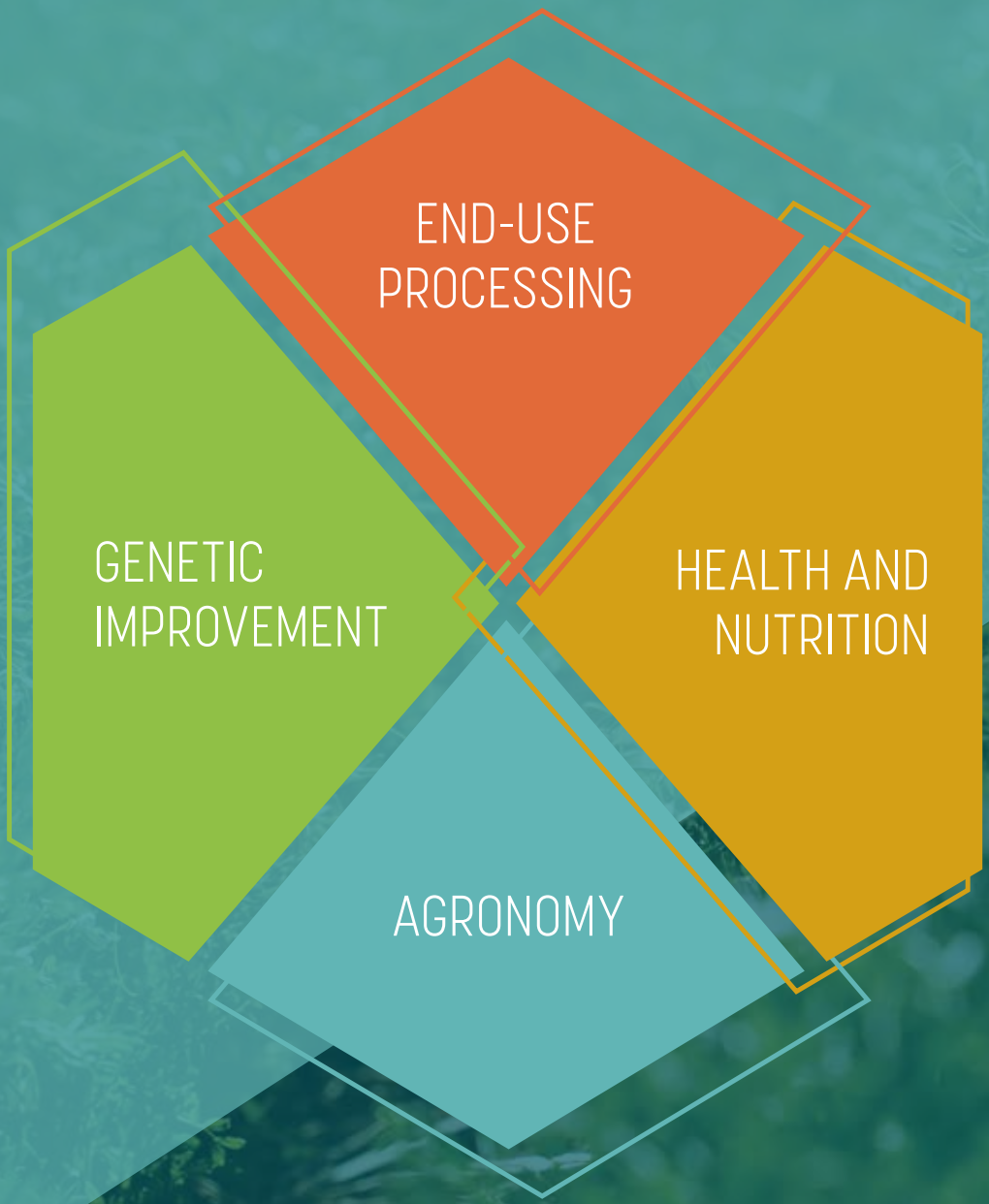
"With our study on kidney disease patients, if this works well — and we already have some evidence that it will — fibre-fortified foods would be ideal for them," she says." I want to be able to communicate that to health professionals so they know there are options for these individuals to use pea hull fibre to help slow the progression of the disease and prevent complications."

In his SPG funded research, Dr. Mike Nickerson is looking at the production process for protein isolates for peas, lentils, and faba beans to help improve the taste of pulses.

04 BUILDING NEW MARKETS: PROJECTS FEATURED

PROJECT TITLE	INVESTIGATORS	FUNDERS	END DATE
Characterization of Structure, Physicochemical, and Physiological Properties of Starch from Canadian-Grown Pulse Crops to Develop Novel Functional Food Ingredients and Functional Foods for Human Health Benefits	Dr. Qiang Liu, Agriculture and Agri-Food Canada **Co-Investigator(s):** Dr. Tom Warkentin, University of Saskatchewan, Dr. Michael Thompson, McMaster University, Dr. Ratnajothi Hoover, Memorial University, Dr. Deng-Jin Bing, Dr. Frédéric Marsolais, Dr. Dan Ramdath, Dr. Rong Cao, Agriculture and Agri-Food Canada	Saskatchewan Pulse Growers ($238,878), Agriculture and Agri-Food Canada	March 31, 2018
The Effect of Variety and Processing on the Protein Quality of Canadian Pulses for the Human Diet	Dr. James D. House University of Manitoba, Dr. Yves Arcand, Agriculture and Agri-Food Canada **Co-Investigator(s):** Dr. Frédéric Marsolais, Dr. Anfu Hou, Dr. Nancy Ames, Agriculture and Agri-Food Canada, Dr. Martin Nyachoti, University of Manitoba	Saskatchewan Pulse Growers ($181,703), Agriculture and Agri-Food Canada	March 31, 2018
Efficacy of Pea Hull Fibre Supplementation on Gastrointestinal Transit Time-Induced Reduction in Proteolytic Fermentation and Enhancement of Wellness in Older Adults, Individuals With Lifestyle-Related Chronic Disease, and Overweight Children	Dr. Wendy Dahl, University of Florida **Co-Investigator(s):** Mark S. Segal, Nancy J. Gal, Dr. Volker Mai, Dr. Charlie Sims, University of Florida	Saskatchewan Pulse Growers ($212,715)	April 30, 2018
Enhancing Quality and Value of Meat Ingredients for Further Processing	Dr. Phyllis Shand, University of Saskatchewan	Saskatchewan Pulse Growers ($75,128)	January 1, 2018
Entrapment of Hearty Healthy Oils Using Protein Isolates by Spray Drying	Dr. Michael Nickerson, University of Saskatchewan **Co-Investigator(s):** Dr. Rick Green, POS Bio-Sciences, Dr. Shannon Hood-Neifer, Saskatchewan Food Industry Development Centre Inc.	Saskatchewan Pulse Growers ($59,225)	November 15, 2019
Growing the Market for Pulse Flours: Creating innovative bakery products and a pulse database for the food industry	Lindsay Bourré, Elaine Sopiwnyk, Canadian International Grains Institute, Adam Dyck, Linda Malcolmson, Warburton Foods Ltd. **Co-Investigator(s):** Dr. Michael Nickerson, Dr. Yongfeng Ai, University of Saskatchewan, Dr. Michel Alianni, University of Manitoba	Saskatchewan Pulse Growers ($1,684,382), Western Grains Research Foundation	March 31, 2019
Improving Pulse Palatability and Health Benefits to Increase Pulse Market Share of Pet Foods	Dr. Lynn Weber, University of Saskatchewan **Co-Investigator(s):** Dr. Murray Drew, Dr. Matthew Loewen, University of Saskatchewan	Saskatchewan Pulse Growers ($305,377)	August 31, 2019
Incorporation of Canadian Pulse-Based Ingredients Into Rice Noodle Targeting the Chinese Market	Dr. Steve Cui, Agriculture and Agri-Food Canada **Co-Investigator(s):** Dr. Shaoping Nie, Nanchang University, Dr. Qi Wang, Guelph Food Research Centre	Saskatchewan Pulse Growers ($98,670)	December 31, 2018
Modification of a Commercial Lentil, Pea, and Faba Bean Protein Isolate Production Process for Improved Flavour Profiles	Dr. Michael Nickerson, University of Saskatchewan **Co-Investigator(s):** Dr. Rick Green, POS Bio-Sciences, Dr. Shannon Hood-Neifer, Saskatchewan Food Industry Development Centre Inc.	Saskatchewan Pulse Growers ($115,000)	December 2, 2019
Modification of Pea Starch for Increased Utilization in the Food Industry	Dr. Paulyn Appah, Manitoba Food Development Centre **Co-Investigator(s):** Alphonsus Utioh, Manitoba Food Development Centre, Joachim Baur, Griffith Laboratories Ltd, Peter Frohlich, Canadian International Grains Institute, Lisa Casper, Manitoba Food Development Centre	Saskatchewan Pulse Growers ($99,824)	December 31, 2017
Opportunities for Canadian Faba Beans in World Markets	LMC International **Co-Investigator(s):** Julian McGill, LMC International	Saskatchewan Pulse Growers ($49,500 USD, $65,229 CAN)	November 30, 2016
Processing Platform for Food Functionality of Faba Bean (3-F Platform)	Dr. Shannon Hood-Niefer, Saskatchewan Food Industry Development Centre Inc. **Co-Investigator(s):** Nienke Lindeboom, POS Bio-Sciences, Dr. Albert Vandenberg, Dr. Michael Nickerson, Dr. Judit Smits, University of Saskatchewan	Saskatchewan Pulse Growers ($399,930)	April 30, 2018
Thermal Pretreatment of Pulses for Innovative Ingredients and Consumer-Ready Meat Products II: Going global	Dr. Phyllis Shand, University of Saskatchewan **Co-Investigator(s):** Dr. Janitha Wanasundara, University of Saskatchewan	Saskatchewan Pulse Growers ($63,541), Agriculture and Agri-Food Canada, InfraReady	March 31, 2018
The Utilization of Pulses in the Manufacture of Crumb Used as a Binder in a Model Meat System	Michelle Sigvaldson, Alberta Agriculture and Rural Development **Co-Investigator(s):** Dr. Jay Han, Alberta Agriculture and Rural Development, Dr. Zeb Pietrasik, Alberta Food Processing Development Centre, Dr. Tom Warkentin, University of Saskatchewan	Saskatchewan Pulse Growers ($155,000)	June 30, 2017
Utilization of Yellow Pea, Lentil, and Faba Bean Fibre and Starch for Meat Product Applications	Dr. Phyllis Shand University of Saskatchewan **Co-Investigator(s):** Dr. Janitha Wanasundara, University of Saskatchewan	Saskatchewan Pulse Growers ($35,026), AGT Food & Ingredients, Agriculture and Agri-Food Canada	March 31, 2018

Pulses are increasingly being used as ingredients in baked goods to improve the health and nutrition of the final products.


END-USE
PROCESSING
GENETIC
IMPROVEMENT
HEALTH AND
NUTRITION
AGRONOMY

RESEARCH INVESTMENT

SPG RESEARCH INVESTMENT

AGRONOMY RESEARCH

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Knowledge Transfer and Translation — Organic Science Cluster	Agriculture and Agri-Food Canada	Dr. Andrew Hammermeister	$12,000
Applying Ecology for Simple, Nutrient Efficient Use Pulse-Based Cropping Systems	Agriculture and Agri-Food Canada	Dr. Chantal Hamel	$39,799
Moisture Management Effects on Soybean and Faba Bean in Saskatchewan	Agriculture and Agri-Food Canada	Dr. Dale Tomasiewicz	$79,890
Managing Herbicide Resistant Weeds in Pulses with Alternative Modes of Action	Agriculture and Agri-Food Canada	Dr. Hugh Beckie	$24,650
Diversifying Cropping Options for the Brown Soils Through Intercropping	Agriculture and Agri-Food Canada	Dr. Myriam R. Fernandez	$68,678
Coordinated Surveillance, Forecasting, and Risk Warning Systems for Field Crop insect Pests of the Prairie Ecosystem	Agriculture and Agri-Food Canada	Dr. Owen Olfert	$100,000
Knowledge, Tools, and Practices to Manage insect Pests of Pulse Crops in Saskatchewan	Agriculture and Agri-Food Canada	Dr. Owen Olfert	$99,762
Infectivity Model for *Aphanomyces Euteiches* in Saskatchewan Soils	Agriculture and Agri-Food Canada	Dr. Syama Chatterton	$290,000
Epidemiology of Chocolate Spot on Faba Bean	Agriculture and Agri-Food Canada	Dr. Syama Chatterton	$121,296*
Enhancing the Long-Term Sustainability of Pulse Cultivation Using System Approaches	Agriculture and Agri-Food Canada	Dr. Yantai Gan	$1,004,036
Moving Forward to Sustainable Development of the Saskatchewan Pulse Industry	Agriculture and Agri-Food Canada	Dr. Yantai Gan	$352,000
Frequency and Sequence of Annual Pulses in Cropping Systems. Phase II	Agriculture and Agri-Food Canada	Dr. Yantai Gan	$125,099
Intercropping Chickpea with Flax	Agriculture and Agri-Food Canada	William May	$23,460
Cover Cropping as Part of a Rotation Strategy to Reduce Pea Root Rot	Agriculture and Agri-Food Canada University of Saskatchewan – Dept. of Plant Sciences	Dr. Syama Chatterton Dr. Steven Shirtliffe	$329,832 $104,000*
Developing Nitrogen Management Recommendations for Soybean Production in Saskatchewan	Indian Head Agricultural Research Foundation	Chris Holzapfel	$123,732
Developing Phosphorus Management Recommendations for Soybean Production in Saskatchewan	Indian Head Agricultural Research Foundation	Chris Holzapfel	$106,740
Adaptation and Establishment of Soybean *Glycine Max* Under No-Till in South Saskatchewan	Indian Head Agricultural Research Foundation Wheatland Conservation Area	Chris Holzapfel Brian Nybo	$67,625
Evaluating Inoculant Options for Faba Beans	Irrigation Crop Diversification Corporation	Garry Hnatowich	$305,780
Investigation into Converting a Combine Grain Loss Signal into a Grain Loss Rate	Prairie Agricultural Machinery Institute (Pami)	Nathan Gregg	$23,848
Evaluation of Cytokinin Producing *Methylobacterium* as an Inoculant for Seedling Performance, Yield Improvement, and Drought and Salt Stress Tolerance in Pea	Trent University	Dr. Neil Emery	$190,000
Secondary Effects of Strobilurin Fungicides on Pulse Crops in Saskatchewan	University of Saskatchewan – CDC	Dr. Sabine Banniza	$168,758
Improved Iron Chelates for Treatment of Iron Chlorosis in Saskatchewan Pulse and Fruit Crops	University of Saskatchewan – Dept. of Chemistry	Matthew Paige	$15,333
Evaluation of Contrasting Forage Pea Cultivars in Mixtures with Cereals for Greenfeed Production in Saskatchewan	University of Saskatchewan – Dept. of Plant Sciences	Dr. Bill Biligetu	$84,079
Management of Volunteer Glyphosate-Resistant Canola in Glyphosate-Resistant Soybean Crops	University of Saskatchewan – Dept. of Plant Sciences	Dr. Christian Willenborg	$93,015
Enhancing Weed Science in Pulse Crops: Towards a robust strategy for long-term weed management	University of Saskatchewan – Dept. of Plant Sciences	Dr. Christian Willenborg	$2,023,021
Effects of Early Harvest on Hard-Seededness in Dry Bean	University of Saskatchewan – Dept. of Plant Sciences	Dr. Kirstin Bett	$115,311
Pea Yield formation in Warming Temperatures — Phenological Mechanisms	University of Saskatchewan – Dept. of Plant Sciences	Dr. Rosalind Bueckert	$92,000

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Using Synchrotron Methods to Detect Heat Resistant Pea — Pollen and Leaf Wax Structure	University of Saskatchewan – Dept. of Plant Sciences	Dr. Rosalind Bueckert	$143,175
Potential Seeds in Heat — Improving Pea Ovule Heat Tolerance	University of Saskatchewan – Dept. of Plant Sciences	Dr. Rosalind Bueckert	$195,069
Effect of Seeding Rate and Seed Size on Lentil Diseases, Weeds, Yields, and Profitability	University of Saskatchewan – Dept. of Plant Sciences	Dr. Steven Shirtliffe	$65,580
Integrating Weed Control for Organic Pea and Lentil Production	University of Saskatchewan – Dept. of Plant Sciences	Dr. Steven Shirtliffe	$104,341
Reducing Weed Seed Production in Herbicide Resistant Weeds with Pre-Harvest Herbicide Application	University of Saskatchewan – Dept. of Plant Sciences	Dr. Steven Shirtliffe	$104,650
Optimum Seeding Rate, Row Spacing, and Disease Management in Faba Bean Varieties	University of Saskatchewan – Dept. of Plant Sciences	Dr. Steven Shirtliffe	$449,591
In-Crop Weed Clipping for Weed Control	University of Saskatchewan – Dept. of Plant Sciences	Dr. Steven Shirtliffe	$144,320*
Developing Field Pea Varietal Blends for Higher Yields and Pest Suppression	University of Saskatchewan – Dept. of Plant Sciences	Dr. Steven Shirtliffe	$101,061
Enhanced Saskatchewan Soil Data for Sustainable Land Management	University of Saskatchewan – Dept. of Soil Science	Dr. Angela Bedard-Haughn	$57,768
Effects of Vertical Tillage on Soil Structure and Crop Yields in Southern Saskatchewan	University of Saskatchewan – Dept. of Soil Science	Dr. Bing Si	$49,766
Crop Water Footprints and Virtual Water Flows: A comprehensive evaluation of crop water use in Saskatchewan	University of Saskatchewan – Dept. of Soil Science	Dr. Bing Si	$115,000
Has Transition to No-Tillage Resulted in More Free-Living Soil Nitrogen Fixation?	University of Saskatchewan – Dept. of Soil Science	Dr. Diane Knight	$114,885
Development of a *Rhizobium* Inoculant for Faba Bean	University of Saskatchewan – Dept. of Soil Science	Dr. Diane Knight	$174,996
Responding to Climate Fluctuations: Development of a *Rhizobium* collection	University of Saskatchewan – Dept. of Soil Science	Dr. Diane Knight	$84,881
Canola Grown Before a Pulse Crop: Is biological nitrogen fixation affected?	University of Saskatchewan – Dept. of Soil Science	Dr. Diane Knight	$205,735
Evaluation of Beneficial Rhizosphere and Endorhizosphere Microorganisms as Bioinoculants for the Control of Soil-Borne Root Pathogens	University of Saskatchewan – Dept. of Soil Science	Dr. Fran Walley	$150,000
Nutrient Content and Release from Soybean Residues in Comparison to Other Pulse Crops in Saskatchewan	University of Saskatchewan – Dept. of Soil Science	Dr. Jeff Schoenau	$61,835
Nutrient Uptake and Nitrogen Fixation by Faba Bean in Saskatchewan	University of Saskatchewan – Dept. of Soil Science	Dr. Jeff Schoenau	$37,519
Crop Response to Foliar Applied Phosphorus Fertilizers	University of Saskatchewan – Dept. of Soil Science	Dr. Jeff Schoenau	$20,010
Tolerance of Pulse Crops to Seed Placed Nitrogen Fertilizer	University of Saskatchewan – Dept. of Soil Science	Dr. Jeff Schoenau	$51,117
Direct Assessment of the Release of Fixed Nitrogen in the Rhizosphere of Pea, Lentil, Chickpea, and Faba Bean	University of Saskatchewan – Dept. of Soil Science	Dr. Richard Farrell	$65,786
Quantifying the Contribution of Pulse Crop Residues to Greenhouse Gas Emissions, Nitrogen Nutrition, and the Growth of a Subsequent Wheat Crop: A dual isotope labeling approach	University of Saskatchewan – Dept. of Soil Science	Dr. Richard Farrell	$368,845
Lentil Input Study	Western Applied Research Corporation	Jessica Weber	$118,680

TOTAL SPG AGRONOMY RESEARCH FUNDING **$8,735,522**

**Projects have been approved and the contract is under development.*
Projects listed reflect those active during the September 1, 2016 to August 31, 2017 fiscal year.
Funding amounts in these tables represent Saskatchewan Pulse Growers' multi-year commitment to each project.

SPG RESEARCH INVESTMENT

GENETIC IMPROVEMENT RESEARCH

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Very Short Season Herbicide Tolerant Soybean Development	Agriculture and Agri-Food Canada	Dr. Elroy Cober	$102,500
Develop and Assess Molecular Diagnostic Procedures for the Rapid, Specific, and Sensitive Detection of Root Rot Pathogens in Symptomatic Field Pea Roots	Agriculture and Agri-Food Canada University of Alberta	Dr. Bruce Gossen Dr. Syama Chatterton Dr. Stephen Strelkov	$109,970
Pea Genetic Improvement Program (PGIP)	Limagrain-Advanta Agriculture and Agri-Food Canada DL Seeds		$120,000
Soybean Variety Evaluation Trial	Saskatchewan Pulse Growers		$38,333
Dry Bean Improvement for Sustainable Production in Canada: Development of dry bean germplasm and varieties adapted to south-western Ontario	University of Guelph	Dr. Peter Pauls	$125,000
Soyagen: Improving yield and disease resistance in short-season soybean	Université Laval	Dr. Francois Belzile	$115,000
Virus Induced Gene Silencing (VIGS) to Test Gene Function in Pulse Crops	University of Saskatchewan – Dept. of Biology	Dr. Christopher Todd	$99,015
Integrating Genetic and Genomic Resources for Lentil Improvement	University of Saskatchewan – Dept. of Plant Sciences	Dr. Kirstin Bett	$341,100
Deployment of Tepary Bean Genetics to Improve Stress Tolerance in Common Bean	University of Saskatchewan – Dept. of Plant Sciences	Dr. Kirstin Bett	$148,067
Application of Genomics to innovation in the Lentil Economy (AGILE)	University of Saskatchewan – Dept. of Plant Sciences University of California Davis	Dr. Kirstin Bett Dr. Doug Cook	$1,517,688 CAD $534,876 USD
Weed Science and Herbicide Technologies for Pulse Crops	University of Saskatchewan – Dept. of Plant Sciences	Dr. Christian Willenborg	$772,850
Control of Flowering Time in Cultivated Lentil	University of Saskatchewan – Dept. of Plant Sciences	Dr. Kirstin Bett	$100,000
Towards Generating Multiple-Fungal Disease Resistance in Lentil	University of Saskatchewan – CDC	Dr. Sabine Banniza	$297,820
Integration of *Aphanomyces* Resistance Screening into Rapid Generation Technology of Lentil and Pea	University of Saskatchewan – CDC	Dr. Sabine Banniza	$483,506
Developing Rapid Generation Technology Involving Wild Lentil Crosses in Order to Produce *Aphanomyces*-Resistant Lentil Varieties	University of Saskatchewan – CDC	Dr. Sabine Banniza	$259,289
Development of Improved Markers for Mycosphaerella Blight Resistance in Pea	University of Saskatchewan – CDC	Dr. Tom Warkentin	$185,150
Sequencing the Pea Genome: Creating a solid foundation for long-term pea genetic improvement	University of Saskatchewan – CDC	Dr. Tom Warkentin	$1,446,773
Pulse Crop Advancement Agreement	University of Saskatchewan – CDC		$22,617,300
Marker-Assisted Introgression of Useful New Diversity into the Pea Genome for Rapid Cultivar Improvement	University of Saskatchewan – CDC	Dr. Tom Warkentin	$175,880
Pulse Crop Regional Trials in Saskatchewan	University of Saskatchewan – CDC	Dr. Tom Warkentin	$1,871,494
Marker-Assisted Selection for *Aphanomyces* Resistance in Pea for Rapid Development of Adapted Pea Varieties with Improved *Aphanomyces* Resistance	University of Saskatchewan – CDC	Dr. Sabine Banniza	$308,360
Genetic Analysis of Flowering Genes and their Associated Effects on Agronomic Performance and Stress Tolerance in Chickpea	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$172,737
Development of Adapted High Yielding Faba Bean for Saskatchewan	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$675,257
50K Single Nucleotide Polymorphisms (SNP) Chip Development for Genomic-Enabling Chickpea Breeding	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$921,998
Development of Metribuzin Tolerant Chickpea: Proof of concept validation of CRISPR based gene editing tools in chickpea	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$318,656
A Reverse Introgression and Genomics Strategy to Develop and Characterize Chickpea Germplasm for Yield and Climate-Resilience Traits	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$197,184

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Toward Next Generation Chickpea Breeding: Resequencing diverse chickpea accessions	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$590,488
Application of Abscisic Acid (ABA) Analogs for Improving Pulse Crop Agronomy and Physiology	University of Saskatchewan – CDC	Dr. Bunyamin Tar'an	$275,000
Western Canada Short Season Soybean Regional Variety Trials	Agriculture and Agri-Food Canada, Irrigation Crop Diversification Corporation, South East Research Farm, University of Saskatchewan – CDC	Bill May, Karen Strukoff, Greg Ford, Lana Shaw, Garry Hnatowich, Jaret Homer, Stacy Waggenhofer, Dr. Tom Warkentin	$82,836

TOTAL SPG GENETIC IMPROVEMENT RESEARCH FUNDING **$32,951,562**

Projects listed reflect those active during the September 1, 2016 to August 31, 2017 fiscal year.
Funding amounts in these tables represent Saskatchewan Pulse Growers' multi-year commitment to each project.
USD funding commitments were calculated at 1.3 exchange rate for the purpose of conveying the total funding for the research area.

SPG RESEARCH INVESTMENT

END-USE PROCESSING RESEARCH

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Characterization of Quality, Bioactive, and Anti-Nutritional Compounds of Pulses Prepared with Various Cooking Conditions and Grown in Different Environments in Saskatchewan	Agriculture and Agri-Food Canada	Dr. Elsayed Abdelaal	$195,081
Characterization of Phytochemicals and Dietary Fibres in Pulse Processing By-Products for Value-Added Functional Food Products	Agriculture and Agri-Food Canada	Dr. Rong Cao	$218,500
Incorporation of Canadian Pulse-Based Ingredients into Rice Noodle Targeting the Chinese Market	Agriculture and Agri-Food Canada	Dr. Steve Cui	$98,670
Characterization of Structure, Physicochemical, and Physiological Properties of Starch from Canadian Grown Pulse Crops to Develop Novel Functional Food Ingredients and Functional Foods for Human Health Benefits	Agriculture and Agri-Food Canada McMaster University Memorial University	Dr. Qiang Liu Dr. Michael Thompson Dr. Ratnajothi Hoover (Late)	$238,878
The Utilization of Pulses in the Manufacture of Crumb Used as a Binder in a Model Meat System	Alberta Agriculture and Rural Development	Michelle Sigvaldson	$155,000
Characterization, Modification, and Commercialization of Lentil Bran as a Food ingredient	AGT Food and Ingredients	Dr. Mehmet Tulbek	$100,000
Growing the Market for Pulse Flours: Creating innovative bakery products and a pulse database for the food industry	Canadian International Grains Institute (CIGI) University of Saskatchewan University of Manitoba	Elaine Sopiwnyk Dr. Michael Nickerson Dr. M. Aliani	$1,684,382
Modification of Pea Starch for Increased Utilization in the Food Industry	Manitoba Food Development Centre	Dr. Paulyn Appah	$99,824
Optimization of Fermentation Platforms (Batch vs Solid-State) for Improving the Value of Pulse (Pea and Fava Bean) Fractions	University of Saskatchewan – Dept. of Food and Bioproduct Sciences	Dr. Darren Korber	$115,575*
Processing Platform for Food Functionality of Faba Bean	Saskatchewan Food Industry Development Centre Inc.	Dr. Shannon Hood-Niefer	$399,930
Development of Innovative High Value Pulse Based Food Products with Enhanced Functional and Nutraceutical Properties for Potential Utilization	Tamil Nadu Agricultural University	Dr. Hemalatha Ganapathyswamy	$199,790
Value-Added Applications of Pulse Proteins for Human Foods	University of Alberta	Dr. Lingyun Chen	$149,500
Quantification and Bioassay Development for Toxicity Testing of Faba Bean Varieties	University of Calgary	Dr. Judit Smits	$234,600
Thermal Pretreatment of Pulses for Innovative Ingredients and Consumer-Ready Meat Products Ii: Going global	University of Saskatchewan - Dept. of Food and Bioproduct Sciences Agriculture and Agri-Food Canada	Dr. Phyllis Shand Dr. Janitha Wanasundara	$63,541
Development of High Value Added Pellet Products Based on Combination of Pea/Lentil Screenings, Lignosulfonate and Calcium Chemical Compounds (Additive), as well as Canola Meal to Maximize Extra Benefit for Pulse Producers and Processing Industry	University of Saskatchewan – Dept. of Animal and Poultry Science	Dr. Peiqiang Yu	$68,195
Salvage Values of Damaged Faba Forage and Faba Bean in Ruminant Livestock Systems: - Effect of Frost/Frozen Damage - Feed Values of Normal Faba Forage and Faba Bean for Both Beef and Dairy Cattle - Effect of Varieties, Effect of Processing Method, and/or Effect of Tannin Level	University of Saskatchewan – Dept. of Animal and Poultry Science	Dr. Peiqiang Yu	$245,691
Enhancing Quality and Value of Meat Ingredients for Further Processing	University of Saskatchewan – Dept. of Food and Bioproduct Sciences	Dr. Phyllis Shand	$75,128
Modification of a Commercial Lentil, Pea, and Faba Bean Protein Isolate Production Process for Improved Flavour Profiles	University of Saskatchewan – Dept. of Food and Bioproduct Sciences	Dr. Michael Nickerson	$115,000
Entrapment of Heart Healthy Oils Using Lentil Protein Isolates by Spray Drying	University of Saskatchewan – Dept. of Food and Bioproduct Sciences	Dr. Michael Nickerson	$59,225
Development of Novel Healthier Plant-Based Shortening Alternative Without the Presence of Saturated and Trans Fats	University of Saskatchewan – Dept. of Food and Bioproduct Sciences	Dr. Supratim Ghosh	$115,000*
Utilization of Yellow Pea, Lentil, and Faba Bean Fibre and Starch for Meat Product Applications	University of Saskatchewan – Dept. of Food and Bioproduct Sciences Agriculture and Agri-Food Canada	Dr. Phyllis Shand Dr. Janitha Wanasundara	$35,026
A Quantitative Assessment of the Anti-Nutritional Properties of Canadian Pulses	University of Saskatchewan - Dept. of Food and Bioproduct Sciences University of Manitoba Agriculture and Agri-Food Canada	Dr. Michael Nickerson Dr. Susan Arntfield Dr. Janitha Wanasundara	$33,408

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Improving Pulse Palatability and Health Benefits to Increase Pulse Market Share of Pet Foods	University of Saskatchewan – Veterinary Biomedical Sciences	Dr. Lynn Weber	$305,377

TOTAL SPG END-USE PROCESSING RESEARCH FUNDING **$5,005,320**

**Projects have been approved and the contract is under development.*
Projects listed reflect those active during the September 1, 2016 to August 31, 2017 fiscal year.
Funding amounts in these tables represent Saskatchewan Pulse Growers' multi-year commitment to each project.

HEALTH AND NUTRITION RESEARCH

PROJECT TITLE	INSTITUTION	RESEARCHER(S)	SPG FUNDING
Acute Human Feeding Trials to Define the Minimum Effective Dose for Reduction of Post Prandial Blood Glucose by Two Common Market Varieties of Canadian Lentil	Agriculture and Agri-Food Canada	Dr. Dan Ramdath	$157,550
Blood Glucose Attenuation and Satiety Levels in Humans Following Consumption of Whole Lentil and Yellow Pea and their Food Products; Effect of Processing and Starch Fractions	Agriculture and Agri-Food Canada University of Guelph	Dr. Dan Ramdath Dr. Alison Duncan	$281,747
Determining the Link Between Pulse Foods, Gut Health, and Chronic Disease	Agriculture and Agri-Food Canada University of Guelph	Dr. Krista Power Dr. Lindsay Robinson Dr. Emma Allen-Vercoe Dr. Jennifer Monk	$329,563
Evaluation of Protein Digestibility and Glycemic Response of Pulse-Based Products Using an In-Vitro Platform Technology	Agriculture and Agrl-Food Canada University of Manitoba	Dr. Nancy Ames Dr. James House	$35,639*
Evidence to Substantiate Function Health Claims for Pulse Flours and Fractions in Food Matrices	University of Manitoba	Dr. Peter Jones	$641,193
Mitigating Arsenic Related Health Problems in Bangladeshi Populations by Introducing High-Selenium Lentils into the Everyday Diet	University of Calgary	Dr. Judit Smits	$283,170
Quantification and Bioassay Development for Toxicity Testing of Faba Bean Varieties	University of Calgary	Dr. Judit Smits	$234,600
Efficacy of Pea Hull Fibre Supplementation on Gastrointestinal Transit Time-induced Proteolytic Fermentation and Enhancement of Wellness in Older Adults, Individuals with Lifestyle-Related Chronic Disease, and Overweight Children	University of Florida	Dr. Wendy Dahl	$212,715
The Effect of Variety and Processing on the Protein Quality of Canadian Pulses	University of Manitoba Agriculture and Agri-Food Canada	Dr. James House Dr. Yves Arcand	$181,703
Health and Performance Benefits of a Pulse-Based Diet for Soccer Players During Regular Season Play	University of Saskatchewan – College of Kinesiology	Dr. Phillip Chilibeck	$30,608
Starting Young: Incorporating local pulses in the menus of Saskatchewan childcare centres	University of Saskatchewan – College of Pharmacy and Nutrition	Dr. Carol Henry	$99,935
The Effects of Lentil Fractions on Short-Term Blood Glucose, Insulin, Food Intake, and Appetite	University of Toronto	Dr. Harvey Anderson	$41,360
Effects of Faba Bean Fractions as Ingredients in Novel Food Products on Glycemia, Appetite, and Metabolic Control	University of Toronto	Dr. Harvey Anderson	$650,000

TOTAL SPG HEALTH AND NUTRITION RESEARCH FUNDING **$3,179,782**

**Projects have been approved and the contract is under development.*
Projects listed reflect those active during the September 1, 2016 to August 31, 2017 fiscal year.
Funding amounts in these tables represent Saskatchewan Pulse Growers' multi-year commitment to each project.

SASKATCHEWAN pulse Growers

207–116 Research Drive
Saskatoon, SK
Canada S7N 3R3
Telephone: (306) 668-5556
Fax: (306) 668-5557
Email: pulse@saskpulse.com
Web: saskpulse.com
Twitter: @SaskPulse