Agknowledge

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ADAPTATION

Building resilience for a sustainable future.

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DEAN'S REPORT

DEE HOBSBAWN-SMITH

In a city with a herd of contented cows grazing a river's width from the centre of town, at a university where the dean of agriculture's home was built before the president's, it should come as no surprise that the College of Agriculture and Bioresources is leading the world in agricultural innovation.

According to dean Mary Buhr, the U of S Livestock and Forage Centre of Excellence, under construction in Clavet, is unique in the world.

"It's a global first," said Buhr. "This three-site facility will link our college's research with the vet school's and what the provincial government did at Termuende, integrating environment, forage, beef, and other livestock—bison, elk and horses—and basic and applied research including cow-calf and grazing."

The facility is on schedule to open in March 2018.

"We have done subsoil environmental monitoring, so we have baseline measure of all the soil characteristics and structure," Buhr added.

Monitoring will continue during construction and as animals are brought in. "We will have very unique in-depth long-term data to observe what happens on land never before used for intensive livestock rearing."

Another successful implementation is what Buhr described as the college's flagship program in Aboriginal land management–the Kanawayihetaytan Askiy (KA) Program, which, translated from the Cree, means, "Let us take care of the land." This program, which began ten years ago as a certificate program for First Nations land managers, has evolved into a curriculum of many parts and possibilities.

"We still offer the certificate," Buhr explained. "But now its seven university-level courses can be used towards our two new two-year KA diplomas in Aboriginal Resource Management or Aboriginal Lands Governance, or the student can stay on and use those credits toward a four-year undergrad degree."

The first cohort in the revamped program took to the halls in 2016, after extensive consultations with a total of 75 Aboriginal community members from 23 First Nations and Metis organizations, together with input and guidance from an Aboriginal Programs Advisory Committee working with the associate dean and lead instructors.

"As we evaluate and evolve [the program], we will have a method of curriculum creation for communities of specific interest," she said. "This is what happens when you keep good records and have great faculty. Developing these new programs took quite a long time, but we wanted to get it right. We've learned it's not always easy to be the first to break ground, but happily the rewards are many."

Equally reflective of agriculture's preeminent role are statistics revealing that the college's undergrad enrolment levels ▸ continued to increase at the fastest rate on campus.

"We had a five-year plan for 6.5 per cent growth to get us to 850 students by 2016," Buhr reported, "but by the fall of that year, we had over 1,320 students. That [increase] is due to innovation in our programs, a real effort to get the word out about the work we are doing, but also to recognition that there are really good jobs to be had in a wide variety of industries that students might not have thought of."

That growth in enrolment beyond that which was anticipated comes with some challenges, she added, particularly "to ensure you have the right educators in front of students. It's a huge challenge but we are proud to be one of the colleges with the highest percentage of faculty instead of term teachers."

The past year also brought in more research funding than ever before.

"This is funding that has come in to our scientists for their work," Buhr said, "due to participation in projects such as the global work on identifying the genome of wheat, as well work with soil remediation and identifying ways to remove contaminants from soil in an elegant manner."

Other vital research projects included improving animal welfare, contributions in economics and policy areas, and work with international partners.

"We celebrated our twentieth year of participation in our work with research partners from Hawassa university in Ethiopia, and started a new project in Ghana," added Buhr.

Nearly fifty per cent of the university's scientific research income derives from the college with only seven per cent of the university's faculty.

"Our faculty members are truly teacher-scholars," Buhr concluded. "We are a globally recognized research powerhouse, but remain engaged in the community. What we do has real practical applications."

The elephant in the room continues to be the provincial government's recent budget cuts to higher education. "It has not been easy for us," said Buhr, "but we are determined to continue to remain a source of excellence in everything we do." ■

> "We are a globally recognized research powerhouse, but remain engaged in the community. What we do has real practical applications."
>
> MARY BUHR, DEAN

Agbio at a glance — 2016–17 stats

1,542 students

1,278 UNDERGRADUATE
264 GRADUATE

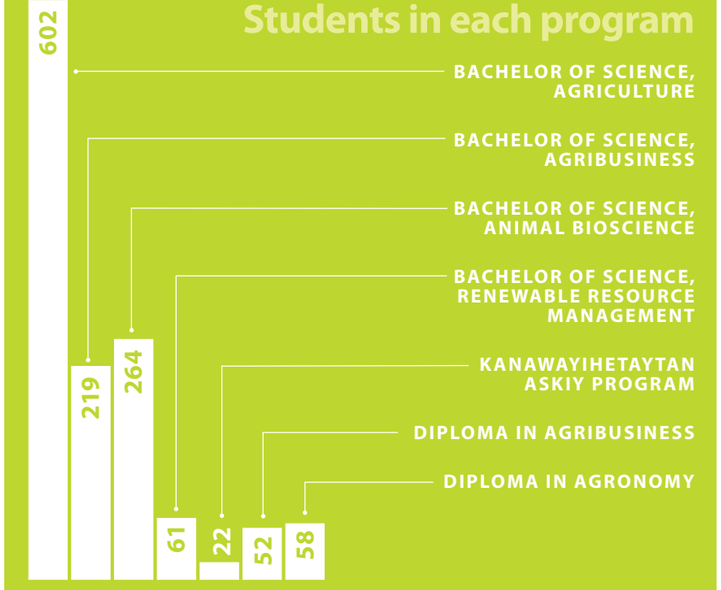
87 faculty

320 staff

New awarded research funding
$34.8M

Scholarships, bursaries, awards
$1.5 M

Students in each program



2017 spring graduates

BACHELOR	CERTIFICATE	DIPLOMA	DOCTORATE	MASTER
190	14	30	10	25

SEND OUT THE CLONES

Tim Sharbel's groundbreaking research into asexual reproduction would be a global game changer

GLENN CHEATER

If all goes according to plan, Tim Sharbel could wind up with a big reputation—as the guy who "turned off sex."

That may not sound good, but in a world trying to feed 10 billion people in the face of climate change, Sharbel's efforts to find the switch that allows plants to reproduce asexually could literally be a lifesaver.

It's not that the U of S scientist is opposed to sex. He's an evolutionary biologist, after all, and the mixing of genes from mothers and fathers is what makes evolution possible. But there is a very good reason for females to go it alone.

"If you're a mother plant and you're not perfectly adapted to your environment, then variability is a good thing because some of those offspring will be better adapted," he said. "But if you are perfectly adapted to your environment, then it's in your interest to have offspring that are genetically identical to you."

The process in which female plants produce seeds all on their lonesome is called apomixis, a long-known but dimly understood alternative form of asexual reproduction. Getting a plant to clone itself would be a huge benefit for plant breeders and, if climate warming models prove accurate, for all of us. Climate change doesn't just mean warmer temperatures, it means more extreme weather—more intense droughts or heatwaves—playing havoc with harvests. It also means pests moving into new territory and new strains of diseases suddenly bursting onto the scene.

All of that will keep plant breeders scrambling to quickly come up with new, more resilient varieties. However, quick is not part of the plant-breeding lexicon.

"Many of our crops are hybrid crops," said Sharbel. "Take corn, for example. A company will have two different genotypes and they will inbreed these lines to make them as homozygous individually as possible. That takes a lot of time, typically about eight generations."

And then you still have to cross these two lines to see if the resulting hybrid offspring express the traits you are after.

But what if you could skip all of that? What if—upon finding an individual plant with improved drought tolerance, better disease resistance, or some other desirable trait—you could get it to clone itself?

"If you could have an apomictic switch, then you could multiply anything as soon as you identify a phenotype you like," said Sharbel, a professor in the Department of Plant Sciences. "It doesn't matter how complex the genetics are behind it, you could just turn off sex and have the plant clone itself.

"To produce a new hybrid now takes years and many resources because you have to go through rounds of inbreeding and crossing. This would allow you to generate a complex hybrid in one generation."

PHOTO BY CHRISTINA WEESE

It's hugely promising, but equally challenging.

Sharbel's 21-member research team is one of the largest in the world studying this "evolutionary conundrum." And that's an apt description.

For starters, apomixis is intermittent. Sometimes females do it on their own and clone themselves, sometimes they're fertilized by male pollen and produce seeds bearing genes from both parents. It's also rare. Only about three dozen (well studied) flowering plants are known to be able to circumvent the normal (that is, sexual) process that creates embryos and then endosperm.

To shine a spotlight on this mysterious process, Sharbel's teams are starting at square one: What genes are involved and what do they do?

To do that, they've capitalized on advances in genetic sequencing and adopted an intriguing line of attack that "considers apomixis like a disease in a plant population." Working with apomictic species, such as Boecher's Rock Cress, St. John's Wort and Kentucky Bluegrass, they divide them into two groups—one reproducing sexually, the other using apomixis. They then take eggs from both and use "very advanced omics techniques" and lots of "high powered statistics" to find genes that are present in the apomictic group but not in the other.

"You look at thousands of individuals," he explained. "If a gene is important, you expect to find it in every apomictic plant. And lo and behold, what we've discovered is high levels of conservation of these genes. Pretty much the only way you can explain this is that these genes are important for this trait."

So far, they've found two "extremely hot candidates" in wild relatives of canola that Sharbel has been working on for years. One has been dubbed APOLLO (APOmixis-Linked LOcus) and the other UPGRADE (Unreduced Pollen GRAin DEvelopment), an equally hopeful name.

So have they found the switch that turns off sex? Maybe.

"Now we're trying to figure out what role they play," said Sharbel. "Genes can act in a number of ways. We have enough information to give us confidence that we can invest time and money in taking these genes and sticking them into corn and canola.

"But that's a shot in the dark. So we also have a large number of experiments looking at different aspects of these genes. One example is what proteins are being produced by these genes. Another is what regulatory factors are involved. We're trying to get as much information as possible."

It's a pursuit Sharbel, a Montreal native, has been pursuing for two decades, mostly in Germany, where he obtained his PhD. He was recruited by the Global Institute for Food Security two years ago, drawn both by its mission and the U of S itself. ("This campus just rocks in terms of departments, researchers, companies that are involved, and so on.")

Of course, he says, everyone has the same question: How soon will he find that switch?

"It's biology, right? It could work in six months, it could work in 10 years. We don't know but we're very excited," he said.

"My goal is to get it to work and then hand it off. Plant breeding is not what I specialize in. There are people who are much better at that. Our role here is to be the discoverers—and we know how to do that." ■

THE REAL DEAL

In the battle against climate change, this is the work that truly makes a difference.

> "Climate change is real. … It's here. And we need to find ways to slow it down."
> RICH FARRELL

GLENN CHEATER

In a time when the U.S. president calls climate change science a "very expensive hoax," it's easy to feel pessimistic about where we're headed.

Then again, folks like soil scientist Rich Farrell fly so far under the radar, few people know how much progress is being made—literally, in this case—on the ground.

"Despite what Donald Trump says, climate change is real," said Farrell, a Rhode Island native. "I don't think you can argue that people aren't partially responsible, I think that's pretty well established. But it doesn't matter. It's real. It's here. And we need to find ways to slow it down."

To appreciate Farrell's work, you first have to know that he's really good at online shopping.

Over the last decade or so, he's quietly put together one of the world's top labs for studying emissions of nitrous oxide (N_2O), a super powerful greenhouse gas. And he's done it on a relative shoestring by scouring the planet for technology that he and his team have then adapted.

There's the Fourier Transform Infrared Spectroscopy gas analyzer—a Finnish device created to track hydrogen fluoride in aluminum smelting plants. Farrell found that baby when its maker mentioned in a paper it could also be used to analyze N_2O.

It's now "interfaced" with an automated gas flux chamber from Nebraska that greatly speeds up the process of obtaining readings.

An isotopic gas analyzer from California has been put to work to map how nitrogen grabbed from the air by plants is converted to an inorganic form and then into nitrous oxide. Soon to arrive is a sophisticated sensor from Denmark that will track nitrogen dissolved in groundwater and how it makes its way back into the atmosphere as N_2O.

"I'm a gadget kind of guy and every couple of months I go online and type in 'nitrous oxide measurements' or something like that to see what's out there," said Farrell, who holds a Ministry of Agriculture Strategic Research Chair.

"When something interesting pops up, I look into it and see if it's something we could use and could get funding for."

It's not been hugely expensive. The lab has 20 automated sampling chambers, but they only run around $5,000 apiece, while the other devices range from just under $100,000 to $160,000.

"I think this is a world-class facility and there are not a lot of labs like this in the world," said Farrell.

To truly appreciate it, you have to be an expert in measuring atmospheric gases, but the bottom line is simple: this technology, some of it able to track emissions in real time, allows researchers to understand how N_2O is created (and how it can be reduced) on a level that wasn't even imaginable until fairly recently.

On the macro level, the broad strokes have long been known: when nitrogen fertilizer is applied and it rains, there's a huge spike in N_2O emissions because of microbial denitrification. Big advances on the micro level have found the microbial genes that are responsible, and how to turn them on and off.

But in between is a big gap about precisely what happens and when. The technology Farrell has assembled allows researchers to "know when events start, when they peak, and when they come down.

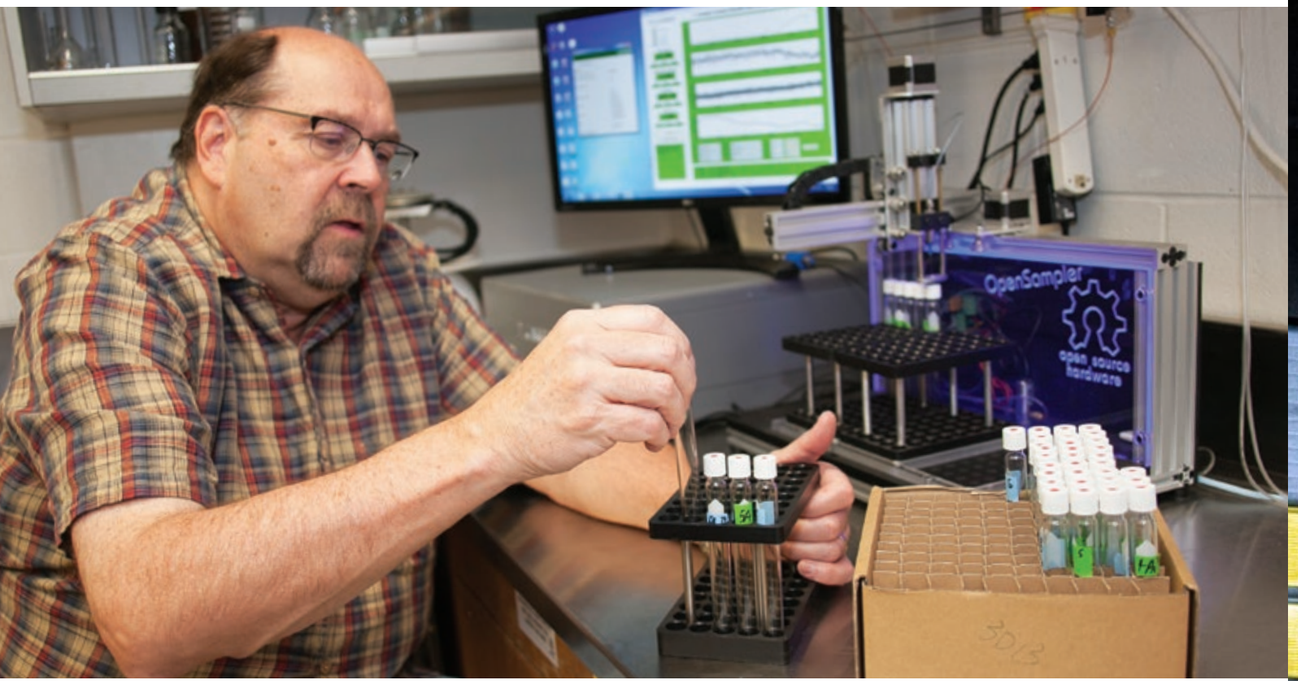
"That means we can design experiments to make the events occur, and the soil microbiology people can collect samples at specific points, track all the activity in the microbes, and look at what's causing these events to happen."

That sort of granular data has very direct real-world applications, whether in evaluating new types of slow-release fertilizers or precisely measuring advanced management methods (such as so-called "split applications" of fertilizer).

Promoting more efficient fertilizer use is another of Farrell's passions.

"We need to improve nitrogen use efficiency, but we have to keep in mind that we're trying to balance agronomic with environmental benefits," he said. "It's easy to say 'we've got to reduce emissions and it doesn't matter what it costs' when you're not the one who has to pay for it."

Typically, just one to two per cent of nitrogen fertilizer is lost as nitrous oxide, ▸



PHOTOS BY CHRISTINA WEESE

but the greenhouse gas is 300 times more powerful than CO_2. It's also an indicator of how much nitrogen is being lost in other forms (N_2 gas and nitrates), so being able to precisely measure N_2O emissions shows how "leaky" a cropping system is.

Pitching the economic benefits of reducing emissions is a lot better than scolding, said Farrell.

"We can say, 'Do this and you'll increase your agronomic output and profits, have a more sustainable business, and improve soil health. And oh yes, you'll get greenhouse gas benefits as part of that.'"

He estimates emissions could be halved without too much pain involved but since they occur even in undisturbed native grasslands, they can't be entirely eliminated. He also points out that energy production and cars are much larger greenhouse gas emitters, but everyone needs to do their part.

"I know some people argue that climate is like a pendulum: You get cold periods, warm ones, dry ones—and the pendulum swings back and forth over long periods of time. But push on a pendulum too hard, it goes off kilter and it doesn't come back.

"That's what we're approaching. If we push this too far, we're not going to recover from it."

Despite the skeptics, hard science does matter. And having a cutting-edge lab does, too.

"The lab helps to drive the direction that we're going in by allowing us to do things that nobody else is doing," said Farrell. "And when we do those things, we first go, 'Wow, this is really cool.' Then we ask, 'What would we need to do this or that?'

"Then we go out and try to find the equipment that would allow us to do that. So, it's a sort of symbiotic relationship."

Farrell is finally getting around to naming the lab. The formal name—the Prairie Environmental Agricultural Research Laboratory—is prosaic, but the acronym is apt.

In the battle against climate change, this PEARL will be especially valuable. ■

> "The lab helps to drive the direction that we're going in by allowing us to do things that nobody else is doing … and when we do those things, we ask, 'What would we need to do this or that?'
>
> RICH FARRELL

Procyshen inspecting a crop in Africa.
PHOTO PROVIDED BY TAYLOR PROCYSHEN

Taylor Procyshen (left) and Abimfoluwa "Gideon" Olaleye, Soil Science graduate students.
PHOTOS BY CHRISTINA WEESE

FINDING COMMON GROUND

Food and an end to hunger lie at the heart of agriculture and agricultural research, regardless of geography, crop or culture.

DEE HOBSBAWN-SMITH

In Africa, maize, or corn, is a daily dietary staple, as predominant as wheat is in North America.

For Taylor Procyshen and soil science graduate student Abimfoluwa "Gideon" Olaleye, the urge to solve hunger through researching ways to improve African soil practices brought them to their current project.

Olaleye and Procyshen now work together at the U of S on researching "microdosing" usage of fertilizer in West African farming practices. Project supervisor Derek Peak explained that microdosing is the "in-soil application of inorganic fertilizer, either NPK [nitrogen-phosphorus-potassium] or urea, depending upon the crop, after seedling emergence. It can double yields compared to controls, and often provides similar yields to broadcasting twice as much fertilizer." The project began in 2012, growing vegetables in Nigeria and microdosing in Benin, with an end game of growing more and better food while bolstering food security in West Africa.

For Olaleye, the path to earning his PhD in soil science in Canada was relatively straightforward: born and raised in Nigeria, he enjoyed the hands-on aspects of his father's work as an agricultural economist. "We [four kids and cousins who visited for months at a time] followed him to the farm, and in the compound we planted beans and corn," he said. "At secondary school, every student had a farm plot—we planted cassava, maize, and used old tools and our hands, not mechanized machines, but hand hoes and rakes. It was fun for me, and the best part was harvest."

After time at Nigeria's Abia State Ministry of Agriculture, Olaleye went to the University of Eastern Finland, where he earned a master's degree in environmental sciences. He came to Canada to further his research in soil science in PhD studies, drawn by the prairies' fame as an agricultural region and the chance to use the Canadian Light Source (the synchrotron).

Procyshen took a more circuitous path to his current work on his MSc, where he is exploring how well the microdosing techniques are being implemented by actual African farmers as opposed to researchers, utilizing Olaleye's soil samples and mechanistic research. He began a Bachelor of Commerce at the University of New Brunswick in 2011, ultimately completing it at the U of S. After having to stop playing hockey at UNB due to injury, Procyshen decided to go to Zambia to work at an orphanage after his second year in university. While there he helped the local farmers and developed an interest in agriculture.

"Farming there was conducted on small plot farms of about an acre, where the farmer would hoe, dig a hole and put in seed, cover it and dig another hole," he said. "I was interested in why they used such an archaic way of farming and how to improve it to feed those who are struggling to eat. I felt that studying agriculture would be the best route to help. I didn't see the starvation you see in commercials, but I encountered hungry and malnourished people."

Procyshen came back to Canada and relocated to Saskatchewan, where he finished his business degree and moved on to agronomy. On seeing a potential link between his commerce degree and seeds in the African soil, he asked, "What is happening in the soil on a fertility basis and what is happening to the farmers' income?"

On a visit to Africa, relying on students from the Nigerian university campus, Procyshen collected samples from farmers' fields and interviewed them for income and expense yields. But there were, of course, difficulties, the ultimate difference between lab tests and real on-the-ground tests. For starters, many African farmers don't keep accurate records, and issues arose in implementing practices set forth in the project due to unforeseen circumstances.

"In one place," he recounted, "they couldn't put down poultry dung or cattle manure because it wasn't decomposed enough and would have burned the plants. Our practice calls for adding organic manure, but in some cases we had to go along with planting without that organic addition. But beyond those difficulties, I saw farmers [in Benin] who are successfully implementing microdosing, and those who were part of the vegetable project [in Nigeria] saw the results of higher yields."

For his part, Olaleye is utilizing the synchrotron to determine the exact chemical forms of nutrients in African soil samples, using a technique that Peak described as being similar to chemical fingerprinting. The next step is to use advanced molecular techniques to determine what microbes are present, and how they are actively cycling nutrients in the soil.

The sum total of analyzing biological, chemical and statistical data along with the increases in soil productivity will offer a clear picture of the African soil system that grows indigenous vegetables and feeds millions while also providing useful grist for the research mills of Olaleye's PhD and Procyshen's master's degree. No small feat, and perfectly aligned with their big picture interest in allaying hunger. ■

LEARNING BEYOND THE CLASSROOM: ECUADORIAN FIELD TOUR

COLLEEN MACPHERSON

On the face of it, Ecuador could not be more different from Saskatchewan.

With a diverse geography that ranges from soaring mountains to steamy Amazon jungle to rugged coastline, not to mention the renowned Galápagos Islands, Ecuador is a world apart from the Canadian prairie. But a closer look reveals the South American country has a strong and growing agricultural sector; it is the world leader in the production and export of bananas, ships flowers to as far away as Russia, is the seventh largest producer of cocoa, and boasts additional significant production of shrimp, sugar cane, rice, cotton, corn, coffee and lumber.

It was that aspect of the country, and more, a small group of University of Saskatchewan agbio students and their professor set out to explore on a 10-day trip to the equator this past February.

Plant Sciences Professor Randy Kutcher led the special Ecuadorian field tour to introduce students to horticultural crop production in the tropics but also to connect them with their counterparts at two campuses of ESPE University there. And it all grew out of a trip he made to Ecuador to recruit graduate students.

"The University of Saskatchewan has agreements with five universities in Ecuador and I was invited to visit in November of 2014," explained Kutcher, who joined the College of Agriculture and Bioresources in 2011 after a plant pathology career with Agriculture and Agri-Food Canada. "We met with many students and professors on that trip, which was really about recruiting, and we currently have a number of Ecuadorian grad students here with us now at the U of S.

"But it's not just about signing agreements and scooping up their best students. It's such an agricultural country; there's a saying that you put a seed in the ground, it will grow. It has a very diverse agricultural economy and a burgeoning flower industry and that's part of what I wanted the students to see."

Having had opportunities to travel when he was a student, Kutcher also wanted students to get a taste of the experience, and the chance to soak up new languages, cultures and politics. It was an opportunity too good to pass up for students Anne Nerbas, Joceline Raisbeck, William Kramer and Alanna Orsak.

In preparation for the trip, Kutcher and the students met weekly to talk about what they would be experiencing, to hear from Ecuadorian graduate students and to begin work on presentations they would give at a student and faculty symposium in Ecuador.

Kutcher said his Ecuadorian colleagues were very helpful, organizing events, connecting him with companies to arrange tours and even providing transportation for the Canadians in their personal vehicles.

The first major event, after seeing a flower production facility, was the symposium. Kutcher spoke to the gathered academics and students about graduate studies and crop research at the U of S, while the Canadian students presented on their undergraduate thesis topics: Orsak on using synchrotron spectroscopy to understand stripe rust in wheat; Nerbas on the future application of apomixes (asexual reproduction) in canola; and Raisbeck on intercropping.

Kramer, a third-year agronomy student from Fairview, Alta., has not started his thesis so he chose to focus on his family's farm operation—the crops they grow, crop rotation, the farm layout and the equipment. "The size of everything left them pretty amazed," he said, describing the audience's response.

The Canadians then heard presentations by Ecuadorian students and faculty, and language was definitely a challenge. "The students speak more English than we speak Spanish," said Nerbas, a crop science student from near Maidstone, Sask., "but the science world is written in English." Raisbeck, who hails from Redvers, Sask., and is studying agronomy, added one Ecuadorian student told her "the only papers that are considered credible (as resources for students) are peer reviewed and in English."

The students also saw how agriculture programs at the Ecuadorian universities are structured, and they noted a lack of breeding programs. "We were at one university where there were just agronomists," said Kramer, "but here at the U of S, breeding is a really important part of the process."

Kutcher pointed out that with multi-year crops like cocoa, a single tree could be harvested for many years before a new

Students William Kramer, Anne Nerbas, Alanna Orsak, and Joceline Raisbeck (left to right) with professor Randy Kachur (centre) in Ecuador.

PHOTO PROVIDED BY ALANNA ORSAK

tree is planted so new varieties take much longer to be adopted by growers. With annual crops, new varieties are critical to increasing yield and addressing problems.

The students did notice an unfamiliar divide within the sector compared to home where the university-producer relationship is paramount. "It was interesting how separate everything is," said Raisbeck. "The farmers are the farmers and the people who work at the university are quite separate."

Following the symposium, the group continued on to tour an organic farming operation, a field crop production research station as well as various production facilities and farms.

There was also a visit to a Tsachila village. The Tsachila are Indigenous people of the Ecuadorian province of Santo Domingo. "It was a chance for the Indigenous people to teach us of their culture," said Kutcher, "and for the students to see the similarities and differences for Indigenous people in Ecuador and Canada. It shows there's a lot of commonality in the world."

With the trip over, the students went to work on the term papers, posters and oral presentations that rounded out the course.

And they all agreed they made the right choice in signing on.

"I'm hoping to do more travelling some day and this was a chance to get my feet wet," said Nerbas. For Raisbeck, the travel experience was a good one but it was also important to see what agriculture looks like in Ecuador, from subsistence farming to giant multi-national fruit growing operations. "We do agriculture in a certain way here, but that's not how everyone does it. Everyone has different issues to deal with."

Everyone on the tour agreed it was made possible in large part by student bursaries from the university's International Student and Study Abroad Centre and the College of Agriculture and Bioresources. That funding covered the cost of the airfare, the single largest expense for the participants.

Kutcher is hoping the course will soon be a fixture on the college calendar. When that happens, and if anyone asks Kramer whether they should participate, he has his answer already prepared: "I'll tell them what people told me when I was considering this course—take advantage of any opportunity you have to travel anywhere." ■

> The travel experience was a good one but it was also important to see what agriculture looks like in Ecuador, from subsistence farming to giant multi-national fruit growing operations.
>
> A STUDENT'S PERSPECTIVE ON THE EXPERIENCE

THINKING SMALL

U of S researcher aims to solve a very big problem with some very little 'guys'

GLENN CHEATER

As eureka moments go, it didn't entirely follow the script.

There was the flash of inspiration and a flush of excitement when a check of the literature showed that, yes, this could be the real deal.

But Fiona Buchanan's exhilarating news wasn't immediately embraced.

"I told my lab manager Kayla Madder, 'We're going to get into mealworms' and she said, 'Oh no, we're not,'" recalled the U of S professor.

Raising creepy crawlies was, she admitted, not something you'd expect a beef cattle molecular geneticist to do. But she was able to convince Madder that mealworms aren't "gross" and raising them actually has an upside.

"They're not maggots, the beetles can't fly, and on winter days when it's minus 30 out, she's in a room that's 25 degrees and has high humidity. So, she loves these guys," said Buchanan.

Colleagues were also a bit skeptical at first, but then quick to see how raising the larvae of darkling beetles could be a game-changer for Prairie wheat farmers, who have been hit hard by soaring rates of a disease called Fusarium head blight.

> "Last year, 80 per cent of the cereal crop on the Prairies was infected."
>
> FIONA BUCHANAN

"Last year, 80 per cent of the cereal crop on the Prairies was infected—80 per cent," noted Buchanan. "So, what do you do with all this infected product?"

One possible, but entirely unexpected, answer to that question arrived out of the blue one day when Buchanan and her husband, a grain farmer, were having breakfast with a farmer friend named Dale Hicks. When Hicks mentioned he had heard of an insect that could eat Fusarium-infected wheat with no ill effects, a light bulb went on. As soon as she got back to her office, Buchanan started searching the research literature. Sure enough, there

Graduate student Carlos Ochoa Sanabria (left) and Fiona Buchanan feeding meal worms to chicks.

PHOTO BY CHRISTINA WEESE

was a paper on a small study that found mealworms could not only survive, but thrive on what would be extremely harmful doses for mammals.

It was, to say the least, a surprising find. Fusarium head blight, which is caused by a fungus, produces mycotoxins, including one called vomitoxin that causes nausea, vomiting, and abdominal pain in humans. In livestock, it's linked with long-term health issues, including decreased feed intake, ultimately impacting growth. Mammals can only tolerate minute amounts—five parts per million (ppm) for cattle and poultry, two ppm for humans, and just one ppm for dairy cows and swine.

Those extremely low tolerance levels mean there's not a lot you can do with Fusarium-infected wheat. Or, at least, until now.

The paper Buchanan found hinted at a solution, but it was a small-scale study on just 30 mealworms given feed artificially infected with four types of Fusarium, none of which are the major variety causing wheat farmers on the Prairies so much grief. Moreover, two of those types caused high mortality rates in the mealworms.

So Buchanan and masters student Carlos Ochoa Sanabria set up an experiment with a much larger sample (10,000 mealworms) and fed them wheat with a range of mycotoxin contamination from Fusarium graminearum found across the Prairies.

The results were everything the team—which included toxicologist Natacha Hogan, insect physiologist Cedric Gillott, and feed processing expert Rex Newkirk, all from the U of S—hoped for.

"These mealworms eat this infected grain quite happily—in fact, they actually prefer it," explained Buchanan. "It doesn't affect their weight gain, their survivability is actually higher, and they convert it into a sustainable, safe source of protein and fat."

Just how mealworms manage this feat isn't known. Perhaps there's some sort of detoxifying bacteria in their gut, or maybe it's something in the genetic makeup of the insects.

"Frankly, I don't really care—I'm just happy they are munching up wheat that's currently worth nothing but could now have a value if this pans out," Buchanan said.

Additional studies are planned: Frass (insect poop) will be tested to see if the toxin passes through the mealworms or whether they are somehow able to convert it into something else. Buchanan's team also has to further investigate whether the critters, when given the choice, will choose healthy plump wheat kernels over shrivelled, infected ones.

A study on the effect on chickens is also in the works. But since the toxin levels in the mealworms drops to 0.13 parts per million (even when the feed has nearly 100 times that level) and the mealworms offer crude protein (with the right amino acid profile) and fat, it shouldn't be a problem.

Neither will production. Buchanan started with 500 mealworms (you can order them online), but now has tubs full of them.

"These guys are very easy to raise," she said. "They like to eat wheat, and they eat it dry. All we have is these big plastic tubs with wheat kernels covered with paper towels that we spritz twice a week. And that's all there is to it."

Many vacated buildings in rural areas (especially if they're near a seed cleaning plant that could supply infected grain and/or screenings) would be suitable for raising these "mini livestock."

"I personally think the chickens would enjoy eating them live and, let's face it, chickens and fish should be eating grubs anyhow because it's part of their natural diet," said Buchanan, although she acknowledged it's more likely they'll be processed into pellets.

It all seems like an odd journey, sparked by a comment over coffee to a cattle geneticist. But it's also a return to a long-held area of interest for the transplanted New Zealander, who came to U of S in 1995. She did her masters on a fungus that infects mosquito larvae, and has a paperweight in her office encasing a giant weta—a mouse-sized insect from her homeland that sports huge mandibles and nasty looking spikes on its back legs.

"They're herbivores but when they fall out of a tree on somebody, you should hear the screaming," she said with a laugh. "I love insects, they're great."

If mealworms live up to their promise, Prairie wheat growers will be saying the same thing. ■

CHARTING THEIR OWN COURSE

Couple take daring leap, swap traditional grain farming to grow "booze and flowers"

GLENN CHEATER

John Cote and Barb Stefanyshyn both had a practical mindset when they headed off to U of S in the mid 1980s to study at what was then called the College of Agriculture.

Cote would study soil science because it was "applicable" to his family's third-generation grain farm, while Stefanyshyn (now Stefanyshyn-Cote) would study animal nutrition en route to becoming a nutrition consultant.

Two decades later, the couple have completely shifted gears. The 3,000-acre grain farm has been sold, and they now joke that they "grow booze and flowers" on their new farm just outside Saskatoon.

But in a way, Black Fox Farm and Distillery has its origins in the days when Cote was learning about side-banding fertilizer and Stefanyshyn-Cote was researching the use of rye in animal feed (the subject of her 1993 master's thesis).

"If we hadn't gone to university, I don't think we would have had the confidence to make some of the decisions we made," said Cote. "The college gave us much more than what we learned by going to classes. The professors were so interactive with us and, even today, some of our closest friends are from the network that got formed in those days."

Calling up a professor or classmate to seek advice became a habit for the couple and their network grew and grew, as did their involvement in organizations that attracted life-long learners. The couple were Saskatchewan's and Canada's Outstanding Young Farmers in 2001, Stefanyshyn-Cote has travelled the world as a Nuffield scholar, and Cote has been a national advocate for applying farm business management practices. The entire family even went on a two-year sabbatical in Mexico and Chile a decade ago.

"It's an adventure we'd highly recommend," said Stefanyshyn-Cote. "Travelling expands your outlook and perspective—extremely valuable for us, but even more so for the kids."

Those experiences reinforced what they learned at university, and convinced them that big leaps were possible.

"Just because you studied for years to become an entomologist doesn't mean you can't do something different," said Cote. "It's all about leveraging what you know."

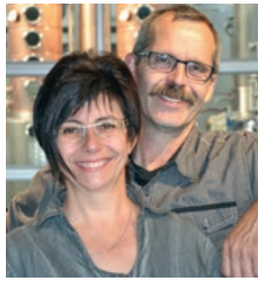
The couple began to rethink grain farming when the oldest of their four children was entering his teen years and they were considering the longer-term future in an area (an hour's drive north of Saskatoon) with a steadily shrinking population.

"If our kids took over the farm, we'd have a dilemma," he said. "We'd have to get much bigger, we'd have to have people working for us. And how do you attract good people when you don't have the amenities, and things like the bus ride to schools just get longer and longer all the time?

"So that prompted a move closer to the city and from there, it all fell into place."

Well, sort of.

The plan when they sold their grain farm in 2010 and bought 80 acres of river valley land was to grow vegetables during the years-long process of setting up a micro-distillery. They soon realized they lacked the scale needed to make a go of veggies and "needed to change something pretty quick before we ended up with a disaster," said Cote.



Barb Stefanyshyn-Cote (left) and John Cote, owners of Black Fox Farm and Distillery.

PHOTOS PROVIDED BY BARB STEFANYSHYN-COTE

> "If we hadn't gone to university, I don't think we would have had the confidence to make some of the decisions we made."
>
> JOHN COTE

That turned out to be growing 250 varieties of flowers on seven acres, making their farm the largest cut-flower producer in the province. ("Which doesn't take much in Saskatchewan," Cote joked.)

The business—which includes a U-pick along with sales to florists, a farmers' market, and weddings—is labour intensive and summers are "pretty full," but it's not a bad way to spend your day, quipped Stefanyshyn-Cote.

It would take until the summer of 2015 before the first batch of gin flowed out of their distillery (the equipment was handmade in Germany and is controlled by state-of-the-art computer technology). Less than two years later, Black Fox became the first Canadian distiller to win a World Gin Award when its barrel-aged vapour-infused dry gin wowed the expert judges at the prestigious English event. And more critically, the operation (blackfoxfarmanddistillery.com) is now generating a return, even though it won't reach full production until next year and its first whiskeys are a few years from being ready for sale.

While Cote admitted their ride into the unknown has been full of unexpected twists and turns, he described the process in very matter-of-fact terms.

"For us, it started with a standard strategic planning session—identifying the problem, listing the goals, and then putting everything on the table," he said. "It has to start very, very high end and then you drill down and identify some options and start investigating them.

"Oh gosh, it can take years but eventually you have a business plan and cash-flow projections, and you're off and doing it."

The key was realizing that learning is not something you're ever done with, said Cote.

"The distilling industry is extremely foreign to us, but what we do know is how to grow the grain, fruit and ingredients," he continued. "Just because you trained to become one thing doesn't mean you can't make a career change, and push the boundary."

Of course, everyone wants to know the secret to doing that, but Cote—still the down-to-earth grain farmer at heart—has a short and simple answer.

"It's just about not being scared to try new things." ■

MORE FROM LESS

Why North Battleford is the place to be in the (surprisingly big) world of livestock feed

GLENN CHEATER

PHOTO BY CHRISTINA WEESE

> "The feed industry does a lot of turning waste ingredients into high-quality products."
>
> REX NEWKIRK

It's one of the biggest resource enterprises on the planet, but most people aren't aware of it.

"We often overlook just how much of agricultural production goes into the feed industry," said Rex Newkirk. "Last year, we were just shy of one billion tonnes of feed manufactured in the world. In Canada, probably around 35 per cent of our total agricultural production goes into the feed industry."

Those sorts of stats have become, so to speak, fodder for meat-is-bad-for-the-planet critics, who argue that farmland would be better used for feeding people, not livestock.

But if you paid a visit to Newkirk's pride and joy—the Canadian Feed Research Centre in North Battleford—you'd see an entirely different side of the story.

"One of the other things that's not well understood is that we use a lot of byproducts to make feed," said Newkirk, associate professor and Ministry of Agriculture Endowed Research Chair of Feed Processing Technology.

"We not only use a lot of off-grade grain, we also divert a lot of products from the landfill that people don't eat. The feed industry does a lot of that—turning waste ingredients into high-quality products."

Both of those areas are a major focus of his work.

Newkirk sounds like a kid in a candy store as he describes various projects he has on the go.

"I grew up on a farm welding, machining, and banging on things with a hammer—I like making things work better," said the ▸

49-year-old. "Here I get to do applied research on getting more value for our crops. That's always been my driving force. What can we do to get more out of our resources?"

The three-year-old research centre looks pretty much like any feed mill (which it was before being extensively retrofitted). But inside, Newkirk and his team of researchers and technicians are busy with a host of projects that attract visitors from around the world. There are three processing lines—from one able to produce 20-kilogram batches to a 20-tonnes-per-hour commercial line that his team gets to use in between production runs by a major feed processor (whose lease helps cover the facility's costs).

But unlike a regular feed mill, Newkirk and his team get to play—using advanced technology to pioneer new feeds and processes that industry can adopt.

Take, for example, their research into grain damaged by a fungus called fusarium graminearum, which produces something called vomitoxin. Humans and livestock can only tolerate minute amounts, but fusarium is widespread. In 2016, roughly 80 per cent of Saskatchewan and Manitoba cereal crops were infected, costing farmers an estimated $1 billion.

A Swedish machine using technology called "near infrared transmission" can scan and sort out in-dividual infected kernels. The research centre obtained one of the first of these machines, worked out the issues in scaling up to commercial applications, and then invited industry players to come and see it in action.

"In a normal feed mill, it would be difficult to mess around with that, but in a research centre like this, we can do that kind of thing," said Newkirk, noting some Prairie feed mills are now installing the machines.

He's equally excited by his new toy—and who wouldn't love a "steam explosion" machine?

"It won't be quite as dramatic as it sounds, but I still think it's a really cool thing," he said with a laugh.

The device breaks down cellulose, the fibrous polymer produced by plants to give strength to their stalks and other structural bits. Thanks to multiple stomachs and the bacteria that live in them, ruminants like cows can break down some of this cellulose. But much of it passes right through them. Making cellulose more digestible would be a double win—better feed efficiency and less manure.

Steam explosion does that by briefly using high pressure and temperature to first melt lignin (the "glue" that binds the fibres together) and push moisture into the fibres. When the pressure and temperature are quickly reduced, the moisture turns to steam and "explodes" (albeit quietly) the fibrous mass.

The technology has been embraced by the ethanol sector, where the holy grail is to make cellulose fermentable so it can be economically turned into fuel. Doing that in large volumes has proven too expensive so far, but Newkirk's idea is that the technique could be adapted economically for feed production.

"I don't want to go to the extremes you need to make it fermentable. What I want to know is: what's the minimum I can do to get the maximum amount of nutrients? And can I scale it up?"

He's taking a similar practical approach to another technology, also using near infrared, to measure ingredients in feed as it's being made. Feed makers always err on the safe side—it's better to have too much protein or energy than too little. Farmers do the same thing, and the result is wasted nutrients going out the back end of an animal.

That's something that Newkirk—who grew up on a cattle ranch near Maple Creek, Sask.—would like to change.

"I think my approach comes from that practical side of farming: how do we feed these cows more efficiently at the least cost?"

It's a quest he's been on for most of his adult life, following a PhD on utilizing canola meal with a 12-year stint at the Canadian International Grains Institute, where he promoted feed grains to buyers from around the world. He now specializes in poultry feed.

His new position fuses all those things together—researching innovative ideas, making them work in the real world, and then inviting in industry players and saying, "Take a look, here's how it works," he said.

"The industry has a lot of smart people and while they work very hard, I see a lot more potential. For me, this is a very exciting place to be." ■

"I think my approach comes from that practical side of farming: how do we feed these cows more efficiently at the least cost?"

REX NEWKIRK

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Spiers, James A
Stearns, Graham L
Stephen, John A
Stephen, Lorna J
Stepko, Janis L
Stilborn, Edward L (Lionel)
Stilborn, Patricia L (Pat)
Stock, Rene J
Straub, Carol A
Straub, Lorne A
Stushnoff, Harvey W
Tatarynovich, John E
Thompson, Elizabeth M
Thompson, Orville L (Lynn)
Tomcala, Gregory G (Greg)
Tonn, Corwin A
Towill, William B
Turner, Jill M
Tuttosi, Dennis S
Usselman, Arnie
Usselman, Heather
Vogel, Joshua P (Josh)
Volk, Michael J
Walker, Murray E
Weaver, George H
Weighill, William H (Bill)
Whitfield, Barry H
Wiebe, Bernhart H (Bernie)
Wilkins, Donald P (Don)
Williams, Earl J
Woloschuk, Rosanne J
Woynarski, Gerard P
Wruck, Jessica A
Zackrisson, Dennis G
Zhang, Li
Zwaan, Brian H

EQUIPMENT CONTRIBUTION AGREEMENTS

Morris Industries Ltd.
- Contour Drill and Cart

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- Self-propelled sprayer

New Holland Agriculture & Moody's Equipment
- Four tractors and a utility vehicle

Weremczuk FMR Ltd.
- Berry Harvester

GIFTS-IN-KIND

Fast Genetics
- Piglets for AgBio Discovery Program

Prairie Swine Centre
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We would also like to acknowledge and celebrate those who have established planned gifts for the College of Agriculture and Bioresources. Making these arrangements today help shape and secure our college's future.

OIL & WATER

People say oil and water don't mix, but the exact opposite is what Supratim Ghosh is working to prove with technology that holds significant potential for two disparate groups in particular—Saskatchewan farmers and beverage producers.

Supratim Ghosh (right) with Maja Primozic, master's student involved in the nanoemulsion project.

PHOTO BY CHRISTINA WEESE

COLLEEN MACPHERSON

Ghosh, assistant professor in the Department of Food and Bioproduct Sciences, is using protein extracted from pulse crops, like peas and lentils, to coat miniscule oil droplets so they disperse evenly through liquids. It's a complex process to create what are called nanoemulsions, but they are vital to the delivery of the nutritional benefits found in ready-to-drink beverages.

"My main interest is food nanotechnology," said Ghosh, who joined the college in 2011. "That's a new name for the discipline where we work at a nano scale on manipulation and interaction of food structures." To illustrate the scale, a glucose molecule is about one nanometre in size, and the period at the end of this sentence is about a million nanometres. Ghosh works on structures between 10 and 1,000 nanometres, "very small. You can't see them."

In ready-to-drink beverages, he explained, certain ingredients like vitamin A, an example of what is called a bioactive, do not dissolve in water but do dissolve in oil. When added to a beverage, the vitamin A is encapsulated in oil "but here's the challenge: how do you disperse the oil in water so it doesn't clump up? What you need are emulsifiers that coat the droplet and have a charge that forces the droplets apart," the effect seen in magnets when similar poles repel rather than attract.

"It's the same when you make mayonnaise," said Ghosh. "The egg yolk acts as an emulsifier to keep the oil from separating out. We're working on an emulsifier to keep the oil droplets dispersed evenly throughout the beverage."

There are very few natural emulsifiers available to the beverage industry, and a growing consumer demand to move away from synthetic compounds, he explained. Gum arabic or acacia, and modified starch are two natural products "but the industry is actively seeking replacements," and it is looking to Saskatchewan pulse crops.

"And here we come to my collaboration with Dr. (Mike) Nickerson," said Ghosh. An associate professor in the department and the Ministry of Agriculture Strategic Research Chair in pulse protein utilization, Nickerson "has the technology to separate out the pulse protein which we then use to create nanoemulsions."

The first step is to modify the protein structure to make it a better emulsifier. To do that, Ghosh developed a technology to loosen the natural bonds that hold the proteins together, followed by emulsifying oil with that protein solution using a high-pressure homogenizer that forces the mixture through a tiny aperture at high pressure—20,000 pounds per square inch (psi). The resulting nanoemulsions have been shown to remain stable for more than two years, he said, an important factor related to shelf life in the food and beverage industries.

One drawback is that pulse protein has a distinctive taste, he said. A preliminary study is currently underway at the Saskatchewan Food Industry Development Centre to look at whether adding the pulse nanoemulsion to existing beverages like vegetable juices and energy drinks affects the properties or taste of the products.

Ghosh also wants to make sure the pulse-protein emulsifier does not inhibit the body's ability to absorb the beneficial ingredients. To explore that, he has set up a digestion system in his lab. "Basically we've used necessary chemicals, enzymes and appropriate time, temperature and mixing protocols to simulate a human stomach and intestines in beakers. We need to understand how the bioactive compounds release during digestion because unless they get into the blood stream, they won't be of any benefit."

Although his primary focus is on food, Ghosh said the nanoemulsion technology has potential for animal feed and other agricultural applications. In fact, he has a couple of bags of feed coated with the nanoemulsion sitting in the lab that he is evaluating for shelf life and the stability of the protein structure.

"I haven't done any work with animal feed but this could be an opportunity to look for a collaborator and say, 'We have the technology, would you be interested?' Oil is already added to feed as an energy source so it is possible the droplets could be used to deliver other bioactives."

But by far the biggest value-added application for the nanoemulsion technology is the ready-to-drink beverage market.

"Beverages are a multi-billion-dollar-a-year industry," said Ghosh. "If crop producers got even a fraction of that using pulse protein, it would be a win-win situation." ■

GROWING GOLD

Canola came of age in Saskatchewan. In the four decades since its debut, it has become the country's major oilseed crop, exceeding wheat in acreage and value. One of the much-lauded originators of canola is Keith Downey, an alumnus of the U of S.

DEE HOBSBAWN-SMITH

Downey had spent the summers since he'd turned fifteen caring for forage crops on Agriculture Canada plots at the U of S. Oil derived from rapeseed—needed for the war effort as a lubricant for the era's steam-powered ships and trains—was planted by Agriculture Canada.

"I hoed and harvested and threshed [rapeseed] in the original plots we grew in the '40s, and later, as a university student, I took charge of plant crossing," he recalled. "Chemistry 5 (organic chemistry) was difficult, and it was one subject I thought I'd never use, but turned out that it was one of the major areas in my career."

Downey earned his bachelor's and master's degrees at the U of S College of Agriculture and Bioresources, then a PhD at Cornell. When he came back to Saskatoon in 1957 to work as an alfalfa breeder at the research station, "They said, 'you can also handle this little rapeseed project because you know more about it from your student days than our other scientists.'"

A few years later, Downey became senior research scientist with Agriculture Canada's research station on campus, and an adjunct professor in the U of S College of Agriculture and Bioresources. The "little" project wasn't really so little.

"We were modifying the fatty acid composition of rapeseed oil to eliminate undesirable fatty acids," he said, "to make it more beneficial [as an edible oil]. The second objective was to remove the sulphur compounds to make the meal more palatable and marketable as a high-quality protein source for livestock and poultry."

Downey learned the importance of colleagues early. His associate, organic chemist Burton Craig, head of the National Research Council's lab, pioneered the gas chromatograph used to analyze fatty acid composition in an oil.

"Before that," Downey said, "you required a pound of seed and a week's time to make one analysis, and that was only approximate. This machine could do it in half an hour. So we built on each other's research."

In the late 1950s, nutritionists concluded that the high erucic acid content in rapeseed was undesirable in an edible oil. Downey and Baldur Stefansson of the University of Manitoba, using Craig's technique, discovered the first "zero" erucic rapeseed in 1960 that led to the evolution of canola from rapeseed. Downey released the first low erucic varieties of the two species in 1968 and 1971.

Downey's first graduate student was Bryan Harvey, and together they developed a technique of splitting a seed and analyzing the oil from half of it, then—if it met their criteria—they germinated and grew the remaining half, thus saving a year in the plant-breeding cycle. Now called the "half-seed" technique, the process has been adopted worldwide for a variety of plant species.

Rapeseed research ultimately resulted in the elimination of sulphur compounds called glucosinolates, then led to the combination of the zero erucic and low glucosinolate characteristics in high-yielding varieties in Downey's and Stefansson's labs.

The two breakthroughs were opening gambits in the chess game of developing canola, the familiar yellow-flowered crop that has now brightens fields across the prairies. Ensuing breeding by Downey and Stefansson led to release of the first "double low" Argentine variety, Tower, in 1974 and the first double low Polish variety from Downey's program in 1977. The improved seed, oil and meal from these and future varieties became known as canola (a hybrid of "Canada" and "oil"). The two men are now considered the fathers of canola.

> "The speed with which science is moving forward is outpacing our ability to keep the public informed—the misinformation out there is scary. Scientists should figure out how to get people interested, to understand how you are changing things to make life better for all of us."
>
> KEITH DOWNEY

PHOTO BY LIAM RICHARDS

Downey has been recognized with countless accolades, including the Order of Canada. As an adjunct professor, he supervised dozens of graduate students, and the research work of an equal number of visiting scholars from developing countries. He taught the scientific method to thousands of school-age children in an ingenious two-year "space seed" program, observing seeds that had gone into orbit on the space shuttle Columbia.

During his 40-year career with Agriculture and Agri-Food Canada, Downey was involved in developing 13 canola varieties, five condiment mustards and a winter-hardy alfalfa, while sharing his expertise globally.

More recently, Downey and his late wife endowed a plant sciences grad student award at the U of S.

"I want to support science and advancement, and the education of young people," he said. "My five children all graduated from the U of S and the education and training they received has been a large factor in the success they have achieved."

What makes the scientific achievement of canola so notable? In 2017, twenty-two million acres were seeded to canola across Canada, and it is now the heart-smart source of ninety per cent of Canada's domestically produced salad and cooking oils, with a fatty acid profile similar to its ancient rival, olive oil; according to Downey, canola is "more important than olive oil."

Downey is 90 this year, still vital, happily picking raspberries in his daughter's small-town Alberta garden. He is still involved in what he started, serving as a brain trust for the annual Canola Industry Day in Saskatoon, a meeting for scientists, technicians and people who deal with the farming public.

"The speed with which science is moving forward is outpacing our ability to keep the public informed," he said. "The misinformation out there is scary. Scientists should continue to forge ahead, but figure out how to get people interested in what you are doing, to understand how you are changing things to make life better for all of us." ■

THE fruits OF SUCCESS

The temperaments and tastes of the researchers who have shepherded the U of S fruit program from its modest beginnings in 1921 have wrought as great an impact as good breeding and astute field practices. Each man who cared for the 80-acre orchard left his mark on the program.

DEE HOBSBAWN-SMITH

PHOTO BY CHRISTINA WEESE

> "Before long we had the world's second largest collection of haskap varieties planted all over our land, 25 varieties from Russia, hundreds of Russian seeds, stuff from Japan, seeds from 16 places. This place is the birthplace of haskap in Canada and North America."
>
> BOB BORS

According to Bob Bors, the current champion of the fruit program, the major achievement of the original professor, Cecil Patterson, "was getting something to survive in Saskatchewan." Just before he retired, Patterson released a flurry of plants – eight pear varieties, twenty apple types, a dozen plums. "I suspect he didn't think anything was good enough, but this was the best he could do," Bors commented.

Patterson's successor, Stewart Nelson, bred tough, productive plants. But Nelson was a chain smoker, and Bors suspects that because sour fruit could cut through his smoker's palate, he crossed in sour wild fruit when adding hardiness to apples, saskatoons and raspberries. Nelson shocked his staff when he ordered the destruction of the raspberries at the conclusion of his 27-year tenure. "He thought they were not good enough," Bors said, "but Rick Sawatzky–who has been here for 46 years–took home the three best. When Nelson retired, Rick brought them back and they became the first varieties released–Red Mammoth, Red Bounty and Steadfast."

Although Les Kerr, who was superintendent of the Prairie Farm Rehabilitation Administration (PFRA) forest nursery station in Sutherland between 1942 and 1966, did not work for the university's fruit program, his efforts had a lasting impact on the program. "Kerr was breeding shelterbelts," said Bors, "but he also was breeding hazelnuts and sour cherries at friends' farms… crossing Mongolian cherries with European cherries, and wild Manitoba hazelnuts with larger European nuts."

Professor Cecil Stushnoff, who took over the fruit program in 1983, collaborated with Sawatzky to round up Kerr's plants and bring them on campus after Kerr's death. Stushnoff also initiated a side project of native fruit breeding in the early 1980's, collecting species of chokecherries, saskatoons and currants, ultimately evolving into the successful saskatoon program.

Tissue culture and propagation specialist Bors arrived in 1999. He is intensely interested in developing nuts and fruits that can be grown commercially, and started with Kerr's rescued sour cherries, by then in their second generation. "No one other than Rick was excited about them, a whole field!" he said.

Bors's strategy in aiming for commercially viable fruit of high quality with organic potential and few pests meant breeding for durable fruit that ripens uniformly, with flexible branches that would allow mechanized harvesters to bend them. By then he'd analyzed the amount of tug needed to pull a cherry off its bush without actually having a machine. [See side bar on next page, "Improved Picking"].

He initiated tissue culture and promoted the cherries at a professional conference in the early 2000s, where they were a sensation. "The Hungarian plant physiologists said all the cherry breeders were jealous," reported Bors. "No one could believe anyone in Saskatchewan could grow any cherries, they thought it was in the centre of the dead zone!" The end result was the Romance series of sour cherries, one of the most successful cold-hardy results of the fruit program.

Next, Bors turned to haskap: in 2000, eight bushes fruited for the first time. Bors did some crosses, met breeders, travelled and bought other varieties. "Before long we had the world's second largest collection of haskap varieties planted all over our land, 25 varieties from Russia, hundreds of Russian seeds, stuff from ▸

Japan, seeds from 16 places," he said proudly. "This place is the birthplace of haskap in Canada and North America." He barely paused before saying, "My next big project is hazelnuts."

Hazelnuts, like sour cherries, sprang from the kernels of Kerr's off-campus sheltercrop plantings. Now in their third generation, the nuts are getting successively hardier as Bors crosses them with Oregon breeding stock. Bors, always with an eye to commercial viability, observed that Ferrero-Rocher, the candy company famous for its hazelnut-chocolate confections, has a factory in Ontario, and reasoned it could be a target market. Two reasons prompted that analysis: the Saskatchewan-bred nuts are resistant to hazelnut blight, and their smaller size is ideal for the company's sweets. Bors's efforts currently centre on hardiness and productivity, but he warned that hazelnut trees "are known for making empty nuts, so breeders have to open a lot of nuts and see what's in there. I haven't tracked it yet, but it will be on my radar."

Also on the horizon is a project involving small red-skinned plums. "They're red inside, you never see that in a prairie plum, but looks cool to me. Size is the challenge, we have some large BC ones for crossing, but we need another generation." Another project involves Crossmount Cider Company south of Saskatoon, where former students of Bors now work. "They are testing large-scale our favourite varieties that we think are best for cider. Eventually we'll know which ones to release as cider apples."

Bors also reported having "a few hundred rhubarb seeds from all over the place, eight kinds from the gene bank, every seed from Canada," and pears, part Asian, part Bartlett, part "horrible-tasting Russian," with the distinctive round shoulders of their Asian ancestors.

The pears are still in the early stages of propagation, but Bors sounded hopeful. "The fruit is small but good enough to bother with," he said. "It could be four or five years." Four or five years are small fruit, a mere blink in the life of a successful orchard. ■

The new berry harvester donated to the U of S fruit program.

IMPROVED PICKING

In 2010, the fruit program's first mechanical harvester, a Polish-made Weremczuk "Joanna 3," cost a mere $40,000, and it arrived only partly assembled. The fruit program's maintenance man spent two weeks assembling it. "After we put it together and used it, the maintenance guy and I sent the manufacturer notes on how to improve the thing," Bors said.

The company so appreciated the input on design improvement that with assistance from G2S Pickin' Patch, the local dealer, it donated a new and improved "Joanna Premium" harvester to the fruit program in the summer of 2017.

The new machine promises to be a vast improvement and arrived in time for the annual Haskap Days in July. "It will be used on cherries, saskatoons and haskap, even raspberries," Bors commented.

"It's especially good for delicate fruit; it shakes the shrub so gently sideways and bends the branches to a 45-degree angle and the fruit only drops a foot, onto the conveyor belt and not on the ground. Plus it will pick lower on the bush. Our haskap will produce a kilogram of fruit after three years of growth, and in the past, the machine would only pick a fraction of that."

Because the new machine only harvests half a bush at a time, Bors can evaluate the other half to determine if the plant will stand up to having its branches bent over, which allows him to breed specifically for the machine. ■

ASSESSING THE ECONOMIC IMPACT OF THE CROP DEVELOPMENT CENTRE

DEE HOBSBAWN-SMITH

For the full report, visit the CDC website at agbio.usask.ca.

"Independence means credibility," said Kofi Agblor, managing director of the Crop Development Centre (CDC), in response to a report released November 2016, assessing the economic impact of plant breeding at the CDC. That independence, Kofi added, is one of the main factors of the CDC's success.

The CDC is situated at the University of Saskatchewan, isolated "so federal/provincial policy changes won't impact us as they would if we were a fully public federal or provincial institute," he continued.

The 68-page report states that CDC varieties have an overall thirty-seven per cent acreage share between 2011 and 2015, and those have higher annual yield increases attributed to plant breeding.

"It takes a while to get a good variety in place," Agblor commented, "but the significant crops in terms of our mandate to diversify have been very successful, and we own close to one hundred percent share in the acreage seeded to pulse crops. In addition, we are seeing increasing market share for barley (feed and malt) and spring wheat varieties."

A significant finding of the report is that producer profitability increased by $3.8 billion between 1991 and 2015 as a result of CDC crop varieties. "Investment pays dividends," Agblor said. "We ask, when you quantify our total operational cost relative to the benefit realized on the farm, are we in the black or the red? When we get a dollar, producers make seven in return. In most industries, if you get three back on each dollar, great. So we did well."

Regarding the economic value of new markets created by new crops over the past five years, the pulse crop acreage expanded by nearly five million acres. As the report states, "The higher margin over cost for many pulse crops allowed producers to capture another $59 million in annual producer profits and the higher pulse acreage added another $293 million in farm output in each of the last five years, when compared to having these additional acres remain in wheat and barley. The resulting higher level of economic activity through the prairie economy contributed to just under 100 new jobs each year, and at least $10 million in additional GDP each year."

"This is easy to assess," Agblor said. "Our intention is to ensure that farmers have alternative crops that are profitable. It's a good story, partly because we have now have a basket of crops that farmers are confident they can grow economically."

In comparison, "we compare favourably to other breeding organizations in developing and releasing varieties that perform," said Agblor. "For example, the International Maize and Wheat Improvement Centre in Mexico gets funding from many countries, including ours, Netherlands, Germany, Britain and France. The Brazilian Agriculture Research Corporation is state-owned, and agriculture is important to that nation, thus they receive a lot more public money than we get. Our scientists have to seek their dollars from multiple sources to carry out their breeding projects and yet they have been very successful.

"Over time, since its inception in 1971, as the CDC delivered value, its team built relationships and found a plethora of investors both public and private, allowing the CDC to leverage its resources," the report concluded. "We are in a position to hedge and manage risk, which goes far beyond research." ■

GAME OF TRANSPORTATION:

Experimental economics in transportation policy

Shipping Saskatchewan grain to market is no game, but James Nolan is using experiments in the form of computer games to better understand how Canada's freight system works, and how it can be made as economical as possible.

COLLEEN MACPHERSON

PHOTO BY CHRISTINA WEESE

Nolan, a professor in the Department of Agricultural and Resource Economics, is an economist breaking new ground by designing computer experiments that emulate Canada's grain transportation system. The aim is to test and validate transportation policies to ensure fairer returns for both railways and grain shippers.

"This is pretty exciting stuff," said Nolan, who joined the College of Agriculture and Bioresources in 1998 after earning a PhD in economics from the University of California, Irvine. "Most people think of transportation research as being engineering based, but my primary interest is using economic analysis to study transportation, figure out how to identify a problem, and then how to fix it."

One overarching challenge is developing policies that will increase competitiveness in a rail industry that only has two players, he said. Another is "the perception, and reality, that freight rates are too high vis-à-vis rail costs."

Understanding how the system actually works is where his experimental analysis game comes in. It uses five subjects, one acting as a railway and the other four acting as agricultural shippers who must move product to a predetermined destination. The players negotiate transportation rates and then the railway moves the product with everyone trying to optimize their own profits.

The first runs of the experiment, conducted within the Social Science Research Lab (SSRL) in the College of Arts and Science, produced results Nolan described as "interesting and somewhat surprising. It turns out shippers have a fairly easy decision-making process and did pretty well, but it was a much more complicated process than expected for the railway player."

While some players came close, no one managed to solve the game in the way Nolan expected, at least not yet. Scientific experiments evolve based on outcomes, he explained, so modifications are underway to make it easier for the rail player to economize within the experimental supply chain.

> "Transportation doesn't get noticed until it breaks; until then, people tend to forget it exists … but freight transportation is so important to Canada. Part of the work that I do is try to make sure it runs smoothly and improve what I can."
>
> JAMES NOLAN

Nolan's research is a perfect fit with his lifelong interest in transportation. Growing up in Montreal, the son of a railway employee, "I built models of everything—cars, trains, planes. Railway operations and finance were dinner table conversation with dad often talking about logistics and car allocation. My research is just an extension of the kind of chatter I grew up with."

Throughout his studies, which began at Concordia University and continued with a master's degree at York University before he moved to California, Nolan focused mainly on urban transportation issues because there were few opportunities to do advanced research on freight transportation.

It wasn't until he came to Saskatchewan that he was able to indulge his passion for rail and logistics, although he admits the whole transportation system is "a bit of an odd duck" from a policy perspective.

"Transportation doesn't get noticed until it breaks; until then, people tend to forget it exists … but freight transportation is so important to Canada. Canada has always been an export-driven country, and we possess a vast transportation system. Part of the work that I do is try to make sure it runs smoothly and improve what I can."

With the gaming experiment, Nolan has created the opportunity to assess both the intended and unintended consequences of current government grain transportation policies, and to pre-test potential future policy changes before they are enacted. The research is still in its early stages, he said, "but this could end up defining the very nature of evidence-based policy making" in Canadian transportation.

In fact, Transport Canada officials met with Nolan in late July to discuss his research and see the grain transportation experiment in action.

With funding from the Saskatchewan Ministry of Highways and Transportation and the Saskatchewan Centre of Excellence for Transportation and Infrastructure in the U of S College of Engineering, Nolan will refine and run more grain transportation experiments. There are several new experimental designs in development, "and the queue is starting to build up. There are many interesting questions that have come out of this."

His ultimate goal, of course, is to publish the results and in doing so, he will be contributing not only to improving freight transportation but also to the use of experimental economics for policy development.

"For many researchers, this is what economics has become. As a scientist, what you do has to be subject to experimental scrutiny. We want to do research that is objective and scientific, and in addition helps develop superior policies moving forward." ■

SAGA highlights

The Saskatchewan Agriculture Graduates Association (SAGA) proudly represents the interests and accomplishments of graduates from the college and school. This past year was another year of notable accomplishments and contributions.

SAGA Honorary Life Membership (HLM) recipients for 2017:

Jim Bessel ('88 S) is renowned throughout the Saskatchewan canola industry, and now his farm consulting business.

Barb Stefanyshyn-Cote ('87 C) is well known for her livestock nutrition expertise and presently the family operated Black Fox Farm and Distillery.

Mary Buhr, professor and dean of the College of Agriculture and Bioresources, received an honorary HLM for all she has accomplished at the U of S.

Morris E. Sebulsky, a '61 C grad, donated the largest sum ever received by the Saskatchewan 4-H Foundation. Morris passed away in early 2014 but stipulated that his bequest be used to further leadership, knowledge and speaking skills in the young rural people of Saskatchewan.

Agriculture alumni Bob McKercher ('54 C) and Ted Turner ('48 S) have written a book about a classic Saskatchewan story of communities coming together to fulfill a dream: To construct the largest agriculture teaching and research facility in Canada. Their new book, The Sodbusters Vision: An Agriculture Building for the University of Saskatchewan, From the Ground Up, walks readers through the history of the vision, planning and completion of the Agriculture Building on the University of Saskatchewan campus. If you'd like to purchase the book, please visit saskaggrads.com. Proceeds go to SAGA.

Several histories of the departments in the college have been submitted by agbio grads and professors. **To read these stories, visit saskaggrads.com.**

Harold Chapman ('43 C), at the age of 100, was awarded the Order of Canada on May 12, 2017. Known for his longtime work in helping farmers establish co-operatives, Chapman published his book, Sharing My Life: Building the Co-operative Movement in 2012.

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