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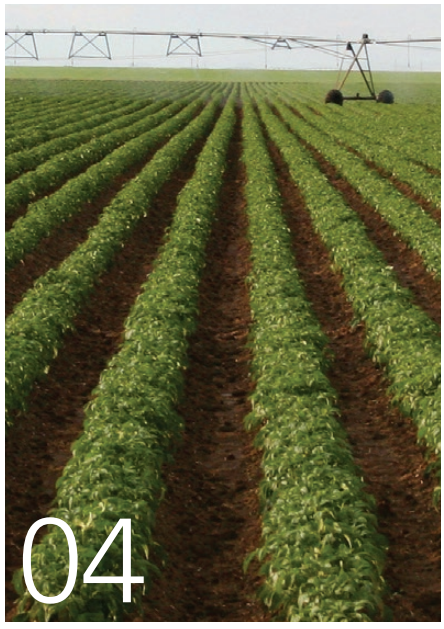

Potatoes and the Food Service Industry

By Mark Halsall

IN JANUARY, I had the pleasure of attending Manitoba Potato Production Days, the annual three-day conference and trade show held in Brandon, Man. I was treated to some stimulating presentations, got the low-down on the latest potato farming products and equipment for this coming growing season, and best of all, had some great conversations with growers. They were out in record numbers this year, and I'm sure a lot of that had to do with the stellar slate of speakers, which included Ian MacRae, Pam Hutchinson, Tracy Shinners-Carnelley, Andrew Ronald, Troy Peters, Jeff Bronsch, Gary Secor, Steve Johnson, Amanda Gevens and Vikram Bischt.

Spud Smart interviewed a number of the presenters, including keynote speaker Shimona Mehta, director of food service at the NPD Group, a global market research and consumer insights company that tracks everything from technology to fashion products. According to Mehta, NPD is also the largest tracker of food service consumer insights in the world, which is why she was invited to Manitoba to talk to a packed house of potato producers.

Mehta spoke about consumer choices in food service, illuminating some of the macro factors that influence why and where Canadians are going out to eat these days and what kinds of food they are ordering. As you might expect, the discussion involved demographics — did you know that baby boomers and millennials (which NPD pegs at ages 18 to 34) are the two Canadian age cohorts who use food service the most? As Mehta puts it, if you know how to cater to these two groups, that's an opportunity to move a lot of french fries.

Mehta also touched on the role of Canada's swelling immigrant population in shaping food service trends. Many Asian immigrants, for example, often don't include potatoes in their regular meals. "Rice tends to be the starch of choice, so understanding those consumers and how we get them to incorporate potatoes into their diet" is one of the challenges facing the Canadian potato industry, she says.

Another challenge relates to overall demand for food services. Mehta says while our country has been one of the few shining lights in the global food service industry since 2008, the market prognosis in Canada for 2014 and even heading into 2015 is flat. As a result, targeting consumers "the right way" is critical to food service growth, she explains, and these days convenience is king. A great indication of that is the exploding popularity of home replacement meals, things like roast chickens and potato wedges, which Mehta says is the fastest growing segment in Canada's evolving food service market.

Along with convenience, factors like healthier food options are also driving consumer choices in today's food service industry in Canada. But the number 1 driver according to NPD's market research may surprise you, and it's certainly great news for folks across the Canadian potato industry. "When we look at it, year after year after year, consumers tell us that the number one factor in choosing the foods that they do, is taste. It's got to taste good," says Mehta. "French fries are the number 1 food in Canada served at food service and that's because consumers love the taste of french fries."

Canada's potato growers can take heart in the fact that, by continuing to produce top-quality potatoes, they are helping fuel the nation's appetite for french fries and other great tasting potato products.

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BLOT on the LANDSCAPE

As researchers warn producers across the country not to underestimate the deceptive new strain currently dominating the late blight pathogen pool, Alberta potato growers are learning more about the enemy at their door.

IN THE HEART of Alberta's processing potato country, Jake Schutter is prepared for the worst. Should late blight invade his fields east of Taber this season, he'll be ready for it. "On our farm, we go with a full arsenal of fungicides. So far, we've been spared any storage losses related to late blight. There have been a few farmers who were not so lucky," he says.

Times have changed for Alberta growers. Up until four years ago, the province was virtually late blight-free. Lately, wet springs and high humidity — uncharacteristic for this region — have nurtured the growth and spread of the disease, causing sticker shock for some growers due to the increased number of fungicide applications needed to protect crops from late blight.

"We went from four sprays to 10 applications of fungicides. It's a huge increase in cost," says Schutter. "We have applied a lot more fungicide and more expensive, newer types to be proactive and control the disease."

All totalled, Alberta growers took a big hit to the pocketbook in 2013. "We estimated about $12.5 million last year in added costs for [crop] protection and shrink in the potato shed," says Jeremy Carter, technical director of the Potato Growers of Alberta.

Not to mention the toll anxiety about the disease has taken on more than a few growers. "[There's] the stress factor of dealing with something you're not familiar with…. Then you have to wonder if it will transfer from the plants above ground into the tubers and, if it does, once you enter storage season you might have breakdown in your bins," says Schutter. "To stop it from keeping you up at night, you have to do your due diligence."

This take-charge attitude is echoed throughout the Alberta potato-growing community, says Terence Hochstein, PGA's executive director. "Alberta growers are very proactive. They have an excellent relationship with each other," he says. "They're doing everything they possibly can to minimize the effect [of late blight] and to try to eradicate it. They view it as a community disease."

Alberta grower Jake Schutter is prepared to use "a full arsenal of fungicides" to protect his potato fields near Taber from late blight.

Photo courtesy of Jake Schutter.

Three-Pronged Attack

Offensive operations are also underway at the PGA via a three-pronged assault including spore trapping, a publicity campaign and a speaker series on the issues surrounding late blight. "Alberta has a history of having some of the highest quality processing potatoes in North America, and we want to keep our record at that. So we need to get in front of this. That's why we're putting this initiative together, this three-pronged approach with our industry," says Carter.

Spore traps will detect late blight-causing spores before they infect crops, while a literature blitz focused on the public, including home gardeners, will be mobilized this spring targeting garden centres, box stores and other venues selling seed potatoes and tomato plants. A speaker series will round out the offensive by providing growers with a comprehensive crash course on everything late blight. The first session was held in February and a second will be held in June, with a follow-up scheduled at the PGA annual meeting in November, covering disease triangles, late blight life cycle, different strains throughout North America, crop protection products, among other topics.

Aimed at bringing all growers up to speed on late blight, the speaker series is already in demand, says Hochstein. "They want to look at ways to deal with cull piles, to deal with all of the problems and the spread of the disease — the growers are asking for this."

Schutter is among those attending the events. He's eager to learn as much as he can about the enemy. He's also witnessed the attitude about-face that has taken place among Alberta growers. "A few years back, everybody just shrugged their shoulders — late blight, that's elsewhere, that's Manitoba or the East Coast, we don't have late blight in Alberta," says Schutter. "The realization has come, especially in the last year — it's the real thing, and we have to watch, we have to be careful where we buy our seed … and we have to take measures with fungicides."

However, it's not only Alberta farmers who will benefit from learning more about late blight this year: even seasoned veterans are being encouraged to take the measure of the latest strain to dominate pathogen populations.

A Deceptive Enemy

In 2013, for the second year running, US-23 was the predominant late blight strain across Canada, confirms Khalil Al-Mughrabi, potato pathologist with the Potato Development Centre, New Brunswick Department of Agriculture, Aquaculture and Fisheries. Although pathogen populations can shift, and shift quickly, there's a good chance this strain will be showing up in farmers' fields in 2014. Understanding the US-23 strain could save farmers from a nasty surprise at harvest or during the storage season.

US-23 entered the Canadian landscape and farmers' fields in 2011 and has since displaced other strains. Plants infected by US-23

Coming to a Field Near You

Late blight, caused by *Phytophthora infestans*, can be spread across continents or regionally. The disease can be transported long distances by the movement of infected potato seed or tomato transplants around the continent or within a country. Wind and rain can also move late blight spores long distances, but this movement is generally considered regional spread.

"A few years back, everybody just shrugged their shoulders — late blight, that's elsewhere... we don't have late blight in Alberta."

Jake Schutter

New Threat on the Horizon

The possibility of different mating types of *Phytophthora infestans* recombining to produce new strains is a reality in Canada. There are two main mating types of the late blight pathogen — A1 and A2. For example, the mating type of US-23 is A1 while US-8 is A2. If the A1 and A2 types have an opportunity to mate, an oospore is created from the union. From that, a brand-new strain is formed. "So far, it's a minor issue in North America," says Rick Peters, a research scientist with Agriculture and Agri-Food Canada. "But it could become a major one if it starts to happen more frequently." That's the good news.

The bad news is recombination could mean new strains that are more aggressive, with characteristics growers and researchers haven't encountered yet. And the oospores could potentially survive in the soil and cause late blight earlier than growers have experienced in the past. "That's already happened in some places in Scandinavia and Europe," says Peters. "It's something we're trying to watch for and keep a handle on."

Under moist conditions, late blight can appear as a white, downy mildew on potato leaves.

Late blight spots can grow to large brown or black necrotic lesions on leaves and spread via petioles to the stems, eventually killing the entire plant.

Photos courtesy of Khalil Al-Mughrabi, New Brunswick DAAF.

still present lesions on stems and leaves typically caused by the late blight pathogen, *Phytophthora infestans*, however, researchers warn the characteristics of this particular strain are different from older strains.

"It's a sneaky strain in potatoes because you tend not to get as aggressive disease in the leaves and stems like you did with US-8. Growers will notice it, but they won't notice it moving as quickly as the older strain did," says Rick Peters, a research scientist with Agriculture and Agri-Food Canada.

But don't be fooled by less damage to above-ground plants when scouting fields. "Unfortunately, what we're finding is it's very aggressive on the tubers. Even in situations where we've had fields with very low incidence of symptoms on leaves and stems, there's pretty high incidence in the tubers because of the spores landing on the soil and washing in with the rain," says Peters. "On the surface it looks not too bad, but suddenly at harvest there's major tuber rot because of its aggressiveness on tubers."

Another difference between US-23 and US-8 — the predominant strain from the mid-90s to around 2010 — is its effect on tomatoes. US-8 was a particularly aggressive strain on potatoes, usually infecting farmers' fields first before causing issues for surrounding tomato growers, whereas US-23 is considered a tomato-associated strain and is especially aggressive on tomatoes.

"Tomatoes in home gardens get hammered close to the end of summer. Those spores can then infect the surrounding potato-growing areas. It used to be the other way around," says Peters.

The specific characteristics of US-23 have influenced disease management strategies. For example, more collaboration between industries is needed, says Peters.

"Now that the tomato is a factor, an understanding between those different industries will be important, as well as home gardeners who we didn't have to think about very much in the past, but now they're part of the picture. We need to educate everybody on this disease and get them involved in the management of it," he says.

Disease management in the field in terms of foliar spray programs won't change all that much, but because infection from this strain may not be as visible and aggressive as older strains, growers should not ease up on protecting their crops, warns Peters.

"We still have to get out there and be cautious in applying those products appropriately — and not waiting — because you may miss some of those early infections that perhaps aren't as visible as they normally would be with the older strain," he says.

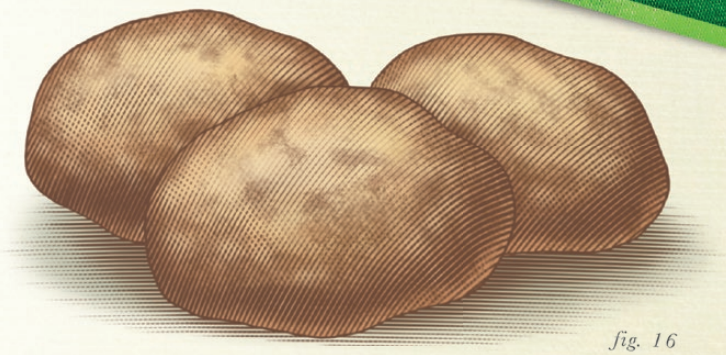

fig. 16

Protato

[prə-*tā*-tō]

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2. **Usage:** "With Luna Tranquility, my ***protato*** crop's really protected against a broad spectrum of diseases."

"Standard management still applies to this strain, it's just tweaked, because its characteristics are a little different. We have to think about tomatoes more than we used to and we have to think about protecting the tubers more now."

Phosphite Fungicides

In terms of chemistries, there are many products available to prevent and manage late blight; however, researchers are singling out one group in particular. "Phosphite fungicides stand out. In recent years, the benefits of phosphites as part of a comprehensive integrated pest management program, particularly to help with tuber blight management, have been promoted," says Al-Mughrabi.

"With these new strains and the changing climate, there's no one who's really safe from blight anymore. Everyone's got to get up to speed on this disease and be proactive in managing it."

Rick Peters

Potato infected with late blight, which causes the skin to darken and discolouration in the flesh.

Photo courtesy of Khalil Al-Mughrabi, New Brunswick DAAF.

Phosphites, such as Phostrol and Confine Extra, are systemic fungicides that move within the plant, even down to the tubers, to prevent tuber rot infections in the field, adds Peters. It is important they be used in addition to a regular spray program for late blight.

"Phosphites have the potential to not only help manage the foliar disease but to help with tuber rot, which is particularly important with this new strain…. They also have a good environmental profile," says Peters.

The word on phosphites is spreading. In Alberta, Schutter is considering adding them to his crop protection toolkit this year.

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"There are some growers that have been using these products for one or two years, mainly those who were closest to the outbreaks, and they've had very good results," says Schutter. "We're thinking to go the same route on our farm. That being said, you should not stop with a normal preventative program."

In the end, Mother Nature will have the final say on what areas are hit and how hard, but changing environmental conditions could mean regions susceptible to late blight will keep shifting. Conventional thinking about the geography of late blight no longer applies. From Alberta with its warm, wet, humid springs to hot, dry summers in Prince Edward Island, weather patterns are certainly deviating from the norm: farmers nationwide must be on alert for late blight this season.

"Stay vigilant and make sure blight management is an important part of your program wherever you are in the country, because with these new strains and the changing climate, there's no one who's really safe from blight anymore. Everyone's got to get up to speed on this disease and be proactive in managing it," says Peters. **Kari Belanger**

Late Blight Scout: What to Look For

- Small, irregularly shaped spots from pale to dark green in colour that appear water-soaked on leaves and stems.
- Under favourable environmental conditions, spots grow to large, brown- or purple/black-coloured necrotic lesions, which may kill entire leaflets and spread via petioles to the stem, eventually killing the entire plant.
- Under moist conditions a white, downy mildew appears on the leaves, mostly on the undersides.

Source: "Understanding and Managing Potato Late Blight," by Khalil Al-Mughrabi, potato pathologist with the Potato Development Centre, New Brunswick Department of Agriculture, Aquaculture and Fisheries.

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The AAFC's accelerated release selections open house in Fredericton, N.B., featured 15 new potato varieties.

All photos courtesy of AAFC.

AAFC'S NEW VARIETIES FOR 2014

Fresh market and specialty potatoes dominate offerings at Agriculture and Agri-Food Canada's accelerated release selections open house

WHEN IT COMES to potato chips, the key to making a good chip is to start with the right potato. That's why Canadian potato chip manufacturers — who according to the international market data firm Research and Markets could see the value of their industry rise to $1.7 billion by the end of 2016 — are always on the lookout for a better potato.

This year, Agriculture and Agri-Food Canada's potato breeding program is offering two new "chippers" for the potato industry to evaluate. Both were unveiled at the AAFC's annual accelerated release selections program open house, held Feb. 12 at the Potato Research Centre in Fredericton, N.B.

One of these new potato chipping selections offers the industry a higher yield and fewer internal imperfections that can reduce chip quality, while the other does better in cold storage, prolonging shelf life and reducing the need for chemical treatment to control disease that can occur in storage.

AAFC research scientist and potato breeder Benoit Bizimungu says both new varieties attracted a lot of interest at the open house. A higher-yielding chipper potato, for example, is definitely something that would benefit the industry, he says.

"It is not very often that we see something that outyields Atlantic, which is the standard for chips in North America. One of them actually outyields Atlantic by about 20 per cent, and has fewer defects than Atlantic," Benoit says, referring to the new AR2014-02 variety. He also noted the variety's good chip quality in terms of fry colour and specific gravity. "We think it's a potential replacement for Atlantic."

A total of 15 potato selections were displayed at the event, the majority for the fresh market as well as specialty-type potatoes with coloured skins and flesh.

"There are several of them with red skins, and we've heard from a number of growers and industry representatives that red-skinned varieties are an important part of the fresh market sector," says Agnes Murphy, another AAFC research scientist and potato breeder on hand at the open house event.

"We know that there is interest in chipping varieties that will perform well in cold storage, and that resist cold sweetening, so that's something else we've been working on. We certainly know that there's big interest in improved varieties for french fry production."

This year's offerings include just one french fry selection, and Murphy acknowledged there were some growers who expressed an interest in seeing more. "These things go in cycles," she says. "We think we have some nice ones in the pipeline, so in the future there should be some more promising [french fry] selections,"

Bizimungu agrees growers can expect to see more processing types being released in the near future. "Every year is different," he says. "This year we have 15 selections, and as in the past, we have a good representation of fresh market selections. In the future we probably want to rebalance and have more processing types. We have many processing kinds in the pipeline."

Murphy says there were 80 growers and other industry representatives in attendance, mostly from Eastern Canada but some from as far away as Alberta. She and Bizimungu both stress industry feedback is crucial to the AAFC's breeding process.

AR2014-01
French fry. Long selection with light russet skin, cream flesh, good french fry, boil and bake scores.

AR2014-02
Chip. Round selection with flaky light yellow skin, cream flesh, good chip colour, high yield; carries a marker associated with resistance to golden nematode, Ro1.

AR2014-03
Chip. Round selection with slightly flaky buff skin, cream flesh, very good chip colour, cold storage potential, resistance to PVX; carries a marker associated with resistance to golden nematode, Ro1.

AR2014-04
Fresh market. Round selection with smooth dark red skin, yellow flesh, good boil and bake; high yield and some indication of resistance to scab.

AR2014-05
Fresh market. Round-oval selection with smooth dark red skin, yellow flesh, good boil and bake, and some indication of resistance to scab; carries a marker associated with resistance to golden nematode, Ro1.

AR2014-06
Fresh market. Round selection with smooth dark red skin, cream flesh, very good boil and bake, resistance to scab and PVX.

AR2014-07
Fresh market/ creamer. Round-oval selection with flaky red skin, light yellow flesh, good boil and bake scores, extreme resistance to PVX and some indication of resistance to fusarium dry rot.

AR2014-08
Fresh market. Round selection with smooth light yellow skin, light yellow flesh, very good boil and bake scores, and extreme resistance to PVX.

AR2014-09
Fresh market. Long-oblong selection with yellow skin splashed with pink, yellow flesh, very good boil and bake scores, extreme resistance to PVY and resistance to wart.

AR2014-10
Fresh market/french fry. Oblong selection with brown russet skin, cream flesh, good boil and bake scores, and fair French fry scores, high yields and resistance to scab.

AR2014-11
Fresh market. Oval selection with smooth dark red skin, light yellow flesh, good boil and bake scores, high yields, resistance to PVX and moderate resistance to scab.

AR2014-12
Fresh market. Round selection with purple skin and white eyes, light yellow flesh, good boil and bake scores, resistance to wart; carries a marker associated with resistance to golden nematode, Ro1.

AR2014-13
Fresh market/ creamer/chip. Round selection with smooth red skin, cream flesh, good boil and fair bake scores, good chip scores, extreme resistance to PVX; carries a marker associated with resistance to golden nematode, Ro1.

AR2014-14
Fresh market/ pigmented flesh. Oval-oblong selection with smooth red skin, pink flesh, good boil score, high yield; carries a marker associated with resistance to golden nematode, Ro1.

AR2014-15
Fresh market. Round selection with smooth dark red skin, light yellow flesh, good boil and bake scores, high yield and moderate resistance to common scab.

"It's good for us to know what kind of traits that growers, industry, processors are looking for, which is fed back into the breeding program," says Bizimungu. "I think it benefits everybody who's involved in potato breeding, selection release and evaluation."

Disease Resistance

While the characteristics of this year's new selections vary widely, they have one thing in common.

"We like to think that each selection offers some strength in disease resistance. I think that six of them had resistance to golden nematode, which is of interest in parts of the country and for export markets. One of them had extreme resistance to PVY. There were several with extreme resistance to PVX," says Murphy, adding another variety has moderate resistance to dry rot.

"It's good for us to know what kind of traits that growers, industry, processors are looking for, which is fed back into the breeding program. I think it benefits everybody who's involved in potato breeding, selection release and evaluation."

Benoit Bizimungu

In addition, Murphy says there's been long-term effort by breeders to try to improve the levels of scab resistance. "Most of them have moderate resistance to scab, as far as we have been able to evaluate to this point."

AAFC showcases the top graduates from its breeding program every year, to allow the industry to learn more about the new potato selections and bid on them to do further trials and evaluations. Successful bidders receive a limited amount of the breeder's seed to grow in their own production setting, and the rights for non-exclusive testing for two years. After the two-year period, cash bids can be submitted for a further three-year period of exclusive testing. By or before the end of this exclusive test period, a six-year licence to commercialize a selection can be negotiated.

Murphy stresses that all of the traits pertaining to disease resistance, storage quality, yield, etc. need further testing for confirmation. "These are not finished cultivars," she says. "They're halfway along the process, and industry has an opportunity to evaluate them in their own production areas for their own requirements. We feel they are the best to judge if these selections will meet their needs." **Mark Halsall**

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Potato Breeding "Not for the Faint of Heart"

Matt Hemphill, executive director of Potatoes New Brunswick, was among the industry representatives who attended Agriculture and Agri-Food Canada's annual accelerated release selections program open house in Fredericton, N.B.

He says breeding a successful potato variety is far from easy. The work being done by AAFC, along with notable private potato breeders like Prince Edward Island's Robert and Joyce Coffin and Bernard Ouellette in New Brunswick, represents a long, laborious process.

"It's a slow go," says Hemphill. "It could take nine to 12 years to bulk up the variety to get it to the commercial production stage. So that silver bullet that's out there for our industry to replace the Burbank is maybe already in the works."

Hemphill will tell you it's also a process that's fraught with financial risk, especially for growers.

"You need to find a variety that yields well, that stores well, that's disease-free and less susceptible to viruses, and we have to get it onto the shelves of the grocery store if we're referring to fresh," he says.

"From a producer perspective, the reality is that somebody ultimately in the end has to consume these varieties, whether it be a french fry, a potato chip, or a fresh potato. So we need consumers, and the challenge from a grower perspective is to take a new variety … and to have the money and investment behind it to get it to market. It's tens of thousands, if not hundreds of thousands of dollars."

Hemphill says another challenge is that the big potato processing companies like McCain and Lamb Weston have their own breeding programs, and that many producers are required to grow what the processors tell them to grow.

Despite the obstacles, there have been notable successes by public and private potato breeders, Hemphill says, citing the Shepody potato, a graduate of the AAFC's breeding program that's now among the main french fry processing varieties, as one example.

"There are some success stories, but it's a bit like going to Vegas," he says. "It's not for the faint of heart, for sure."

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PROTECTING GENETIC RESOURCES

Why wild potato species and heirloom cultivars play a crucial role in future food security.

FROM TIME TO time, new potato diseases may break out, or old diseases and pests may spread into areas where they were, thus far, unknown. Wild potato species and heirloom cultivars represent a great treasure in terms of genetic resistances against current and/or future diseases and pests, and therefore represent a very valuable resource for future generations of potato producers and consumers alike.

Many of the wild relatives of the potato are growing in areas that, from the standpoint of potato cultivation, could be considered rather unusual. Some of these species are now losing their natural habitat, as a result of such factors as deforestation, increased grazing pressure, irrigation of dry lands and changing farm practices, including the use of herbicides and destruction of field borders with increasing field sizes.

When the natural habitat for these wild species changes drastically, the plants are often no longer able to compete with the new surrounding vegetation and, as a result, may become extinct. Several effective solutions are now in place to prevent the loss of these valuable resources for the future.

Gene Banks

One way to preserve the valuable genes that endangered wild species may contain is to preserve them off-site in gene banks. There are seven major potato gene banks around the world. Because they are seen as public trusts, they are managed and funded by national governments.

The principal North American potato gene bank is located in Sturgeon Bay, Wis. Its current holdings include nearly 5,000 samples of more than 140 species. In addition to contributing to this gene bank, Canadian scientists also have access to its vast resources for future research.

Most gene banks publish inventories of their holdings to provide scientists relatively easy access. An efficient way to maintain and distribute these genetic resources is via "true" or botanical seed. Recent developments in tissue culture enable gene banks to multiply and ship various potato genotypes in vitro, which literally means "in glass".

A potato plantlet growing in vitro.

Photo courtesy of Walter De Jong, Cornell University.

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Heirloom Cultivars

Heirloom cultivars are also described as heritage, traditional, vintage, antique or classic cultivars. It has been suggested that for a cultivar to be considered heirloom, it should be at least 50 years old. Such cultivars may contain useful genes that are no longer present in modern cultivars used today.

There are many heirloom cultivars. Examples of North American heirloom cultivars include All Blue, Banana, Green Mountain, Irish Cobbler and Warba.

A sack of Andean seed potatoes on sale at a marketplace in Peru.

Cultivars from the Andean Mountains represent a valuable storehouse of distinctive traits.

Since potato cultivars are maintained by vegetative propagation, they tend to accumulate viruses and other diseases that can be readily passed on to the next generation through the tubers. Diseases carried in potato tubers can be a problem when potato cultivars are exchanged on an informal basis, that is, without the benefit of a seed potato certification program.

To avoid this problem, Agriculture and Agri-Food Canada operates the Potato Gene Resources Repository at the Potato Research Centre located in Fredericton, N.B. The repository's 2012 annual report shows an inventory of 166 accessions, of which 49 per cent are heirloom cultivars.

Nearly all of this material is maintained in disease-free condition in vitro, and is available in small quantities for breeding, research and evaluation purposes, as supplies allow. Descriptions of many heritage cultivars, including pictures, can be found in the Potato Gene Resources Newsletter as well as in catalogs of the Seed Savers Exchange in the United States and Seeds of Diversity Canada.

Photo courtesy of Hielke De Jong.

Botanical or 'true' potato seed like this represents one of the most efficient ways to maintain and distribute the genetic resources of potato.

Native Andean Cultivars

The International Potato Center in Lima, Peru has extensive holdings of more than 4,000 native Andean cultivars — potatoes originally domesticated in the Andes Mountains — in its gene bank. Many of these cultivars are several centuries old and represent a great treasure of distinctive traits including unique colours and shapes, nutritional qualities, and genetic resistances against current and/or future diseases and pests.

Many of these native cultivars are also maintained in several easily accessible "potato parks" in the country, where local Peruvian farmers not only care for them but also maintain the social/cultural values of specific cultivars. The potato parks are open to the public; the best known one is located in Sacred Valley of the Incas in Cuzco, Peru.

Potato parks represent a novel approach towards creating a greater public awareness of the importance of conservation of valuable cultivars. This in turn is part of humankind's insurance policy for future food security. **Hielke De Jong**

Photo courtesy of Kent Loeffler, Cornell University.

The Warba potato is one example of a North American heirloom cultivar.

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Stopping Potato Greening

A cure may be in the works for sunburned potatoes — which is music to the industry's ears.

PRINCE EDWARD ISLAND research scientist Bourlaye Fofana is confident that potato greening could become be a thing of the past. Research began last year at Agriculture and Agri-Food Canada's Crops and Livestock Research Centre in Charlottetown, P.E.I., to create a potato that will not turn green when exposed to light.

Fofana's research team, which includes a breeder, pathologists and chemists based in New Brunswick, Alberta and P.E.I., are working on a solution to potato greening and associated toxicity that they believe lies in potato genetics. New genetic tools available in the lab allow researchers to go through thousands of potato seeds to find the genetics they need to bypass toxic compounds that are highest with potato greening and which will help accelerate the breeding process of new potato lines.

Fofana's team has chemically treated true seed harvested from potato fruits, which look like a tomato fruit. They are currently growing 2,500 lines of potatoes in a greenhouse in Charlottetown, expecting to produce a non-greening, non-toxic potato. The initial target was 10,000 lines, but "I am getting confident we will have most of our outcome from the first batch," says Fofana.

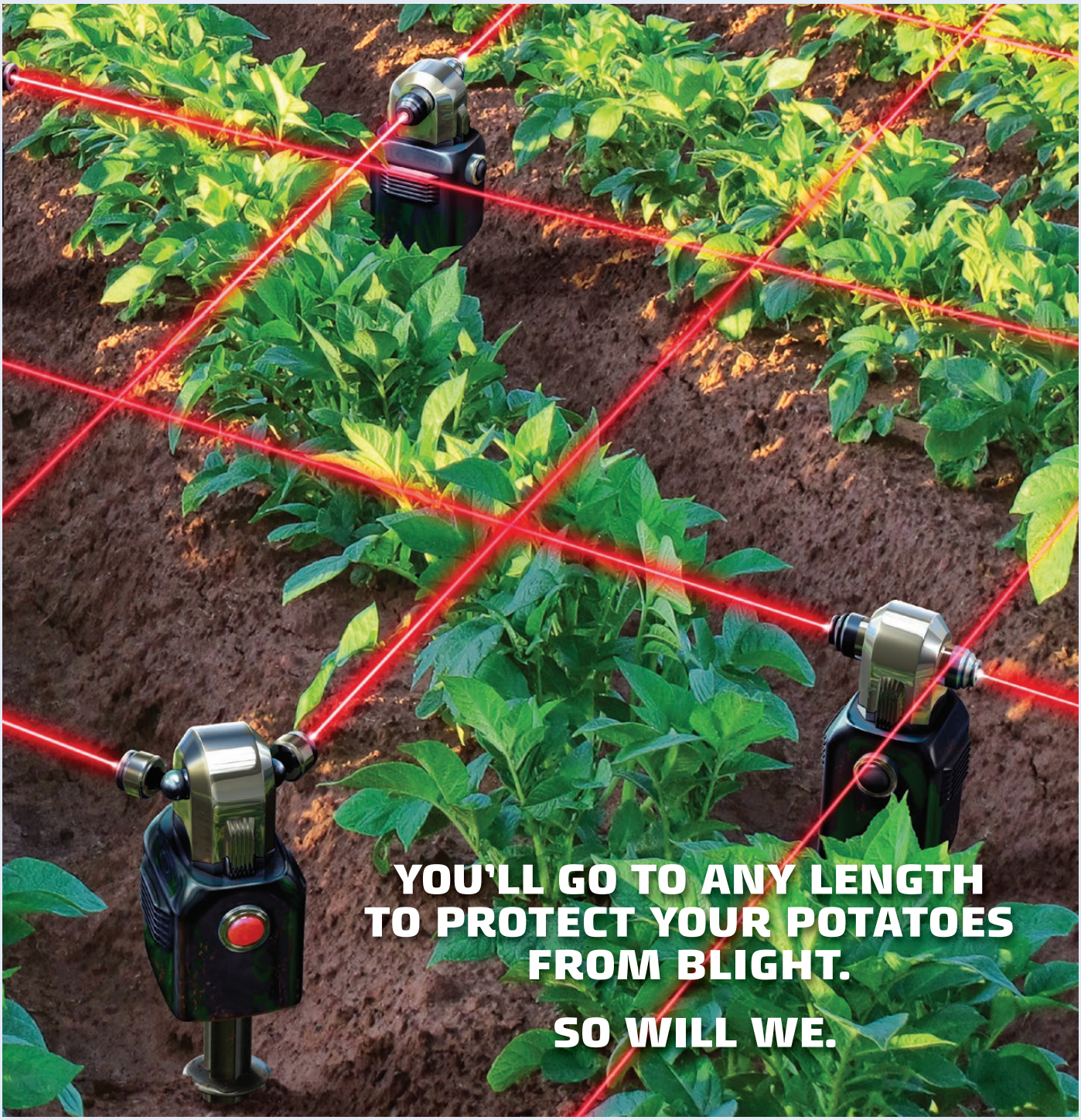
He adds that because the program is based on selective breeding and does not involve genetic modification, the resulting potato tubers could be grown anywhere in the world, and therefore likely wouldn't face restrictions from GMO-free countries. "[Our goal is simply] to generate a germplasm for breeders, and the breeder will be looking at that for development and what qualities they want in the tuber," says Fofana.

Greening has always been a problem for the potato industry, and according to P.E.I. Potato Board General Manager Greg Donald, is responsible for both losses in the field and also consumer complaints at the retail level. The board represents the Island's 330 or so potato growers, and lobbies government on their behalf. It also communicates directly with consumers as part of its extensive marketing efforts.

"It's not a secret in the industry that consumption of fresh potatoes has been on the decline quite significantly. The figures in Canada show the per capita consumption of fresh potatoes has decreased 48 per cent in the last 15 years. I'm not going to say that greening is the reason, but I would say it's a contributing factor," says Donald. "We take very seriously all feedback we get from consumers. We have a consumer response line that we manage, and greening is one of the more common concerns for people calling. The majority of the time, that greening occurs on the store shelf. It's not from the [field]."

Photo courtesy of John Morrison, AAFC.

Prince Edward Island research scientist Bourlaye Fofana, who's heading up a Charlottetown-based study to create a non-greening potato, inspects potato plants grown from true seed treated with a chemical designed to cause random genetic mutations. The study is designed to create tubers that will be free of glycoalkaloids, which are toxic compounds that cause potato greening.



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While too much sunlight can result in sunburned potatoes, artificial light in grocery stores can also cause greening.

Effect of Artificial Light

Greening can occur on the store shelf when potatoes are exposed to artificial light. It's becoming even more of a problem in the 21st century, Donald notes. "Grocery stores are now open 24/7. So there's artificial lighting in all the time, and the potatoes are further subject to it there."

But greening also occurs in the field when potatoes are exposed to sunlight, often referred to as "potato sunburn." Donald notes that producers do everything they can to prevent sunburn, but some green potatoes always get through. "They do the best they can to have a good hill formed and carry out other practices to reduce sunburn in the field, including tarping their loads during transportation, but despite their best efforts, there are still losses," he says.

Fofana's seeds have been treated with ethyl methanesulfonate, a compound that produces random mutations in genetic material. He expects to pinpoint about 100 candidates for the breeding program that will be free of compounds known as glycoalkaloids, which occur naturally in potatoes but at higher levels in greening potatoes.

The glycoalkaloids can cause bitterness, and can also have a toxic effect in high doses, although actual cases of glycoalkaloid toxicity in humans as a result of potato consumption are virtually unheard of. Fofana says glycoalkaloids, if consumed in high doses over a long period of time, could have a cumulative effect on the body. According to its website, Health Canada has established a maximum level of 20 milligrams of glycoalkaloids per 100 grams (fresh weight) of potato tuber. This maximum level is applicable to all potatoes that are commercially sold in Canada, the website states.

Concerns about toxicity aside, greening is primarily a flavour and aesthetic defect in potatoes, the severity of which fluctuates widely depending on the variety of potato and growing and storage conditions. It's not just an issue in P.E.I. and Canada, but internationally as well, adds Donald.

> "There's a potential for loss all along the process. Generally speaking, right from field to fork, there are challenges with greening."
>
> Greg Donald

"I would speculate on the production side of things, it's probably not unreasonable to say at least two per cent or so [of the total P.E.I. potato crop] is being lost every year, or culled if you will, due to sunburn," he says. After you consider all the growers in Canada at large, it really adds up, Donald goes on to say. "After that, you see losses on the retail end of things. If a potato is in a package and is exposed to light in the store, there's a potential for loss all along the process. Generally speaking, right from field to fork, there are challenges with greening."

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A non-greening potato would give Canadian potato farmers a new marketing edge, says Donald. "If they can eliminate that problem, then their saleable product is going to increase."

That's music to Darryl Wallace's ears. He's an Island potato grower and also sits on the P.E.I. Potato Board as a director. He grows about 500 acres of potatoes every year, and says he'd save at least two per cent of his crop each season if he could grow a potato variety that wasn't susceptible to sunburn. Mother Nature largely determines how much of his annual crop he'll have to cull due to greening caused by sun exposure.

> "It's not only about selecting good genetics — it's basically to make sure the genetics we are selecting are safe, high-yielding, resistant to pathogens and also have other characteristics the industry is looking for."
>
> Bourlaye Fofana

"Sometimes you'll get a great big rain in the spring that will wash some of your hills off, and then of course you're going to get more sunburn," says Wallace, who grows both processing and table potatoes. "It's quite a concern in the table market, more than anything."

Eliminating greening on store shelves will also make consumers happy, Donald says, and could help consumption of fresh potatoes to increase. "If [greening] can be removed as an issue or complaint from consumers, then that's better for everybody," he says.

Boon to Retailers

Eliminating greening at the store level would be a major boon to retailers, says Peter Chapman. He's the owner of GPS Business Solutions, an independent consulting firm in Atlantic Canada focused on increasing produce sales for growers, food processors and retailers. Chapman has assisted with produce marketing for Loblaws stores on the East Coast, and says if greening is eliminated, potato retailers will be able to promote the vegetable to consumers in a whole new way.

"As [potato] consumption changes, we've seen people switch from a 10-pound bag to a smaller one, or even bulk," says Chapman. "Some stores are great for selling bulk potatoes simply because they're in the right marketplace. If you're in downtown Toronto and people want to buy one potato, you can do it that way. But in a lot of stores, you really have to manage the size of the display for bulk potatoes. If we can prevent greening, that would be a big win on the retail side."

Photo courtesy of John Morrison, AAFC.

Green-skinned potatoes in the lab at Agriculture and Agri-Food Canada's Crops and Livestock Research Centre in P.E.I.

Without having to worry about greening, retailers can commit themselves to far more attractive potato displays, he adds. "They can be a lot more confident that they'll get a good shelf life out of it and give the consumer ample time to get in and buy it." Chapman estimates that on the retail side, shrink on bulk potatoes is "significantly higher" than the two per cent loss that Donald estimates happens at the producer level. "Retailers are very conscious of the amount we're putting out versus what we're selling," says Chapman.

Fofana's research wraps up in 2016, at which point the best non-greening potato varieties produced during the study will be unveiled. After that, he says two to three more years will be required to address other performance tests in the field. "It's not only about selecting good genetics — it's basically to make sure the genetics we are selecting are safe, high-yielding, resistant to pathogens and also have other characteristics the industry is looking for," says Fofana. **Marc Zienkiewicz**

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Potato Mop-Top Virus

Possibly spread by contaminated soil, this fungal disease can be difficult to stop once it becomes established.

POTATO MOP-TOP VIRUS, or PMTV, is a disease that is on the rise in the United States, says retired American plant pathologist Jim Crosslin. Since pathogens don't respect borders, some potato experts believe there's a chance PMTV could become an issue in Canada, too.

While many potato viruses are transmitted by aphids or nematodes, PMTV is spread by spores of the powdery scab pathogen *Spongospora subterranea*. Powdery scab favours moist soil and cooler temperatures ranging from 11 to 15 C.

PMTV is widespread in parts of both North and South America, and can remain alive for up to 18 years in soil within fungal spores or in host plants. It has also been found in parts of Europe, especially in Scandinavia.

Crosslin says that while PMTV is considered a quarantine pathogen in some countries like South Korea, the disease has not been considered a quarantine pathogen in North America since 2002.

"Once infected Spongospora is present in the field, it remains infectious for many years," says Crosslin, who worked with research geneticist Chuck Brown at the U.S. Department of Agriculture Agricultural Research Service's vegetable and forage crops research laboratory in Prosser, Wash. Brown has been doing a lot of work with PMTV and he's worried that the virus is more widespread than researchers once believed. Since PMTV is vectored by a fungus, the disease is very mobile, Brown says.

Researchers aren't sure exactly how the pathogen moves, but Brown thinks that it travels by way of contaminated soil on equipment or on the tubers themselves, making it difficult to manage. Brown is concerned there's a chance PMTV could get out of control in North America, especially in cases where growers aren't seeing symptoms.

Photo courtesy of Khalil Al-Mughrabi, New Brunswick DAAF.

The symptoms of potato mop-top virus include spots, rings and arcs, which are only sometimes visible on the surface of infected tubers.

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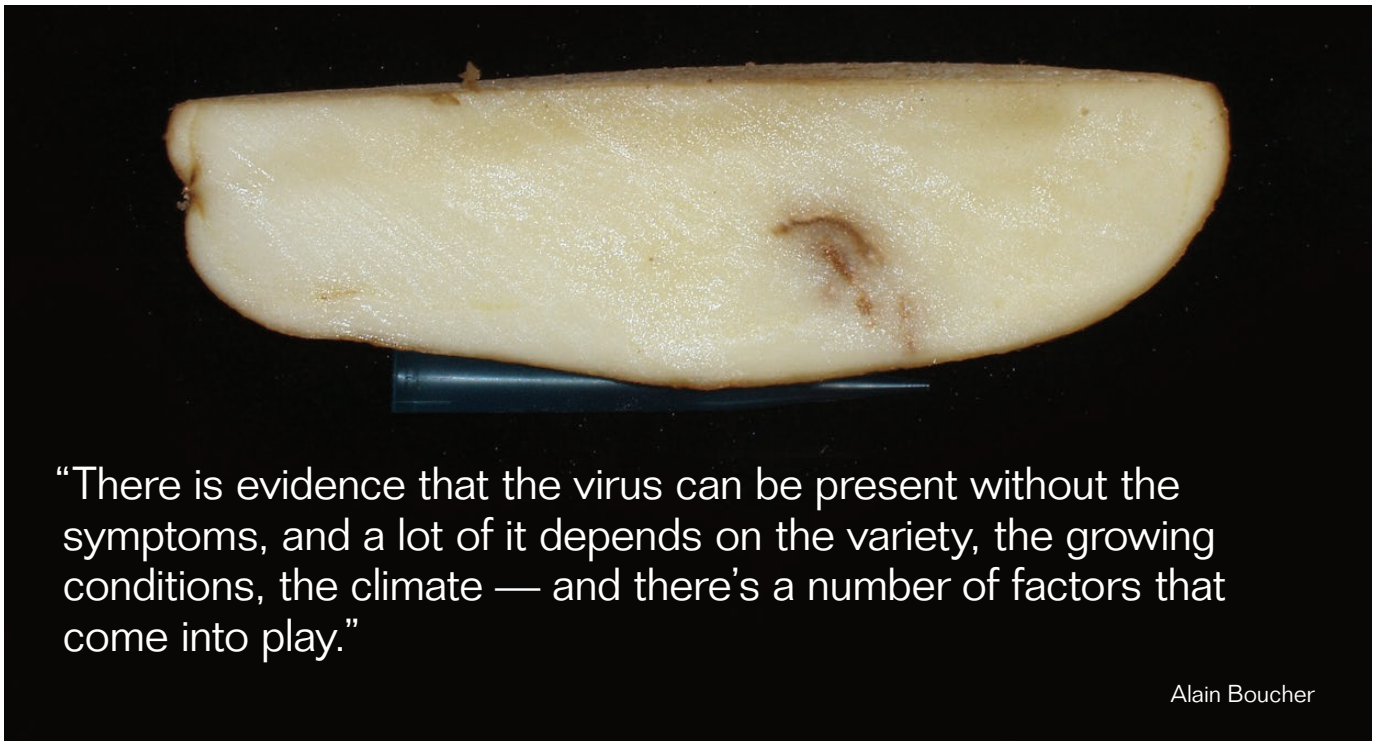

"There is evidence that the virus can be present without the symptoms, and a lot of it depends on the variety, the growing conditions, the climate — and there's a number of factors that come into play."

Alain Boucher

There can be numerous symptoms once Spongospora has infected potato roots with PMTV, he says. These include spots, rings and arcs, although stacked or concentric rings appear to be the most characteristic symptom of the disease. Sometimes these rings are visible on the tuber's surface, but more often than not, they are not visible, Brown says.

"Sometimes there will be yellow spots, arcs or chevron patterns on the leaves of infected plants," says Crosslin. "However, these foliar symptoms seem to be rare in potatoes grown in North America."

Making identification even more difficult is the fact that PMTV symptoms can sometimes resemble those caused by other soil viruses, including tobacco rattle virus. To identify if powdery scab is present, a commercially available "immunostrip" can be used, says Brown. Test results are obtained in mere minutes, and only a small amount of tissue is needed for testing. To identify and distinguish PMTV from TRV, a well-outfitted virological laboratory may have to employ a highly specialized test since symptoms of these two viruses in tubers can be virtually identical. Knowing which one is the cause of disease is important because fumigation will control the nematode that infects potato with TRV.

According to Khalil Al-Mughrabi, potato pathologist with the New Brunswick Department of Agriculture, Aquaculture, and Fisheries, "PMTV transmission through seed tubers is variable, and the virus may be lost after several generations in the absence of powdery scab."

PMTV in Canada

The Canadian Food Inspection Agency and the United States Department of Agriculture Animal and Plant Health Inspection Service conducted an international survey in 2001 and 2002. More than 3,000 tuber samples from different lots of seed and ware potatoes were tested. The samples originated from various sources, both in the Canada and the U.S.

Before testing began, PMTV was considered a pest of quarantine status in both the United States and Canada. According to an article by H. Xu, T.L. DeHaan and S.H. De Boer published in April 2004 in the journal *Plant Disease,* determining the impact of PMTV on commercial potato production in North America was difficult.

"After it appeared that we detected PMTV in 4.3 per cent of potato consignments during surveillance of imported and domestic potatoes in Canada, our study concentrated on unequivocal identification of PMTV in potatoes from North American sources," says the paper. "Although our results clearly indicated that the virus was widespread throughout the potato-growing regions of the United States and Canada, the actual incidence and distribution could not be deduced from the data due to the irregular number of samples tested from any one area."

Al-Mughrabi says officials in the Canadian potato industry were informed of the presence of PMTV in Canada and the United States during a national conference call with the CFIA back in 2002. At that time, he says, government regulators in both Canada and the U.S. agreed to develop a joint management plan. Under the plan, PMTV would no longer be considered a quarantine pest in either nation, but rather a pest that would be controlled through careful management.

According to Al-Mughrabi, the joint potato virus management plan announced by the CFIA and the U.S. Department of Agriculture-APHIS in December 2002 was focused at maintaining high-quality seed potato production. "This plan is aimed at managing the risks associated with several pests that occur in both countries, including potato mop top virus, potato Y virus complex and tobacco rattle virus, through seed certification measures," he says.

Alain Boucher, national manager of the potato section at CFIA, says they haven't seen any PMTV-related issues that would be considered "alarming" in recent years. Boucher says it was determined in 2002 that PMTV did not cause significant economic harm, and therefore, did not need to be treated as a quarantine pest.

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"There is evidence that the virus can be present without the symptoms, and a lot of it depends on the variety, the growing conditions, the climate — and there's a number of factors that come into play," says Boucher. "Presently, PMTV is being regulated as a regulated non-quarantine pest through the seed potato certification program requirements.

Mathuresh Singh, director of Agricultural Certification Services at the potato diagnostic laboratory in Fredericton, N.B., says he's received calls from potato growers requesting PMTV testing, and some of those tests have come back positive. However, he's not sure how widespread PMTV may be in Canada. Potato seed frequently moves between Canada and the United States, so if PMTV is on the rise in the U.S., then it's possible that it could be increasing here in this country too, Singh says.

"We might have [it] already, but we really don't know the extent because it travels through seed," he says, adding that once seed is established in the field a disease like PMTV could be difficult to get rid of.

When PMTV was first identified in Canada in 2002, Boucher says it was symptomless, making it extremely hard to detect. Now, though, Singh says internal symptoms have been found in some instances where tubers were tested for PMTV in Canada.

According to both Al-Mughrabi and Brown, tubers infected with PMTV are unmarketable. They also agree that a widespread outbreak of the disease could conceivably have the effect of restricting the trade of seed potatoes and the movement of planting material between Canada and the United States.

According to Al-Mughrabi, PMTV is best managed through exclusion and sanitation practices. "A viable option for management of PMTV is preventing the movement of the virus and its vector from affected to unaffected regions through quarantine and certification of seed tubers," he says.

Crosslin agrees that the first step in minimizing losses due to PMTV is to keep the virus out in the first place. It's important for growers to plant clean, powdery scab-free seed, and make sure to clean their equipment between fields to prevent movement of infected soil to new locations, he says.

"Long rotations between potato crops can help reduce infection levels, but may not be practical in all areas," says Crosslin. "Some weeds, especially nightshades, can serve as hosts of Spongospora, so good weed control may help reduce infection levels."

Susceptible Varieties

Where PMTV is a problem, chemical control has not been an option, but planting less susceptible cultivars could be a viable solution, since there are differences in cultivar susceptibility, says Al-Mughrabi. He suggests avoiding susceptible varieties, like Kennebec, Shepody, Yukon Gold and Red Pontiac in fields where the presence of PMTV may be suspected.

Brown and his team at USDA's Agricultural Research Service have conducted trials on standard varieties and are particularly optimistic about the PMTV resistance of one variety, POR06V12-3. So far, it has shown low levels of internal infection and zero latent infection during testing, Brown says.

Brown's team aims to continue these trials this year. They're hoping to return to fields with particularly high disease pressure, and plan to include all of the standard varieties in those trials.

Melanie Epp

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A Bayer CropScience scientist conducting a plant growing test at the company's R&D biological products lab in Davis, Calif. Comparisons are made between plants treated with biological products, plants treated with chemical pesticides, and plants with no treatment at all.

Photo courtesy of Bayer CropScience.

THINKING BIORATIONALLY

'Natural' alternatives to chemical pesticides providing new weapon against potato pests.

IN THE BATTLE against potato pests, what's old is becoming new again. Biological pesticides, or biorational pesticides as they are also known, are gaining growing acceptance among farmers, despite the fact that biological pest control technology is anything but new. In fact, this type of pest control — that is, using 'natural' substances produced by Mother Nature to combat diseases and insects — is the oldest weapon in a farmer's arsenal.

"The first pesticides ever really invented were from natural sources; those would be copper-based fungicides," says Dave Bell, an agronomist with crop input supplier United Agri Products Canada, which distributes biorational and synthetic products.

While opting for natural products rather than synthetic chemicals to control pests may not be a new concept, what has changed is the move by an increasing number of growers choosing to make natural pesticides a part of their overall pest management strategy.

"We believe that the market is somewhere in the $1.5-billion range for biorationals globally," says Bill Stoneman, executive director of the Wisconsin-based Biopesticide Industry Alliance, which is dedicated to fostering adoption of biopesticide technology. "That's a pretty small slice right now. But our growth rate is estimated to be [nearly 16] per cent per year. That's a significantly faster rate of growth than the chemical side. The data suggests that biorationals will represent six per cent of the market by 2017."

Export Concerns and Biorationals

As the European Union implements strict rules governing maximum residue levels for pesticides (in some cases, these levels are required to be reduced by as much as 50 per cent), residue management on crops is a hot topic among growers. As environmental regulations around the world become stricter, an increasingly important consideration for growers is making use of pesticides that won't disqualify their potatoes from export to certain areas of the globe.

"Growers have to think globally, because they don't know where their potatoes [and other crops] are going to go, where they

will be exported to," says Janet Porchak, marketing director for UAP Canada.

UAP used to distribute Serenade fungicide before that product was acquired by Bayer CropScience as part of its purchase of the biorational product firm AgraQuest in 2012. Serenade is based on a certain strain of *Bacillus subtilus* bacteria, also known as QST 713. It's a biofungicide that aids in the suppression of early blight in potatoes when applied foliarly. Serenade works by producing metabolites which, from a fungicidal standpoint, "punch holes into the cell membrane of the disease," according to Andrew Dornan, senior field development representative for Bayer CropScience Horticultural Products.

Manitoba's Kroeker Farms has used the Serenade product, in addition to several other biorational pesticides. Based in Winkler, Kroeker Farms is known as one of Canada's leading potato producers, and is Manitoba's largest producer of organic potatoes. Marvin Dyck, an agronomist at Kroeker Farms, says biorational pesticides offer an advantage as far as the environment is concerned. "They tend to work more with the surrounding environment and less against it. There are less unintended organisms caught in the crossfire," he says.

That's one of the big benefits biorational products offer to not only organic produce growers — who rely on them to keep disease at bay while sticking to the principles of organic farming — but also to conventional farmers as well. "We go looking for these products, we're actively seeking them out, and want to get as many into our lineup as possible," says UAP's Bell. "If you can deliver value to the grower, then they will choose those lower-impact products. Every farmer I've met is an environmentalist, and a big part of that is they want to minimize their impact."

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>
> Dave Bell

Organic red potatoes from Manitoba's Kroeker Farms, which makes use of biorational pesticides to ward off disease and insects.

Photo courtesy of Kroeker Farms.

McCain Foods, the world's largest producer of french fries, is also taking this approach. Over the 2013 crop year, agronomy staff at McCain Foods Canada evaluated various commercially available and novel biorational products in replicated field trials, as well as commercial strip trials. "McCain Foods is continually looking to minimize the environmental impact of potato production and to reduce the active ingredient load applied to our potatoes while achieving top potato yields and quality," McCain Foods Canada agronomist Emily Snowdon says. "At a time of increasing consumer awareness with regard to food production and food safety, it is imperative that McCain Foods encourages our growers to take advantage of these alternative products."

Stoneman emphasizes that consumer awareness is indeed a big driving factor in the biorational market. He says if a company like McCain is "telling their growers to use [biorational pesticides], or qualifying their growers based on their ability to use these products, that will drive growth. Consumer demand is having a big impact," he says. "In the frozen food industry — and it's true for potatoes and other vegetables — many of those acres are contracted acres. Here in Wisconsin, the pest control decisions on processing vegetable production acres are made by the contract company. I think there will be more of that as these markets want a direct channel to the farm and some control over what they're selling."

Integration Into Non-Organic Farming

It is integrating biorationals into conventional agriculture, not just into organic farming, that companies like Bayer CropScience and UAP are focusing on. "The thing growers have to keep in mind is that a number of the [biorational products] need to be used within a program. They're not a silver bullet, but neither are synthetics," Porchak says. "Farmers are stewards of their land, and they're very dedicated to that and willing to look at new technologies, but it has to have the efficacy they're looking for."

Dyck recommends using check strips to evaluate the efficacy of a biorational product. "Take yield and quality samples and compare results with fields where you use more mainstream products as inputs," he advises.

Snowdon says growers who choose to use a biorational product should do so carefully and be mindful of what pest they are trying to eradicate. "Because biorational products typically have a narrow pest spectrum, the McCain agronomy team highly recommends that growers looking to use such products ensure that a

stringent scouting program is in place. It is important that growers make sure they are applying the correct product to control the problem pest," she adds.

New Products Available

The Serenade fungicide product line is expanding — according to Dornan, Bayer CropScience recently received registration in Canada for Serenade Soil, which is applied in furrow at planting to protect young potato plants against rhizoctonia. It works by allowing the QST 713 bacteria to establish and colonize on the developing roots of the plant, continually producing the active metabolites which provide the fungicidal activity.

The number of new biorational insecticides available in the marketplace for potato farmers is growing as well. Valent BioSciences produces DiPel, which has an active ingredient called *Bacillus thuringiensis* (Bt) that kills many species of worm pests including some that affect potato plants. Valent also produces XenTari, which also targets worm pests and uses *Bacillus thuringiensis var. aizawai* (Bta), composed of protein crystals and viable endospores, as its active ingredient. It's meant to be used along with DiPel.

Kroeker Farms uses the Entrust bioinsecticide from Dow AgroSciences. Its active ingredient is Spinosad, a relatively new insecticide derived from a bacteria known as *Saccharopolyspora spinosa*, first isolated from a sugar mill rum still. This bioinsecticide targets Colorado potato beetle larvae.

Photo courtesy of Kroeker Farms.

Kroeker Farms uses a variety of biorational pesticides in its organic potato operation.

Benefits of Low-Dose Synthetics

The pesticide industry understands it's not just the "natural" label of biorational products that appeals to farmers, but also the agronomic benefits derived from using them. UAP is marketing traditional synthetic insecticides that give farmers many of the benefits of a bioregional product in a synthetic pesticide. "I would broaden the definition of bioregional products. There's traditional chemistry that's so effective in very low doses and with such a very good environmental profile, even though it may not be derived from a natural source," notes Dave Bell, an agronomist with United Agri Products Canada.

Beleaf 50SG is an FMC product that protects potatoes against aphids, which has a pre-harvest interval of seven days for potato and a maximum residue level of 0.2 parts per million. Ramón 10 EC from Chemtura controls Colorado potato beetle, and has a PHI of 14 days for potato and a MRL of 0.05 parts per million. Both products are a part of UAP's umbrella brand Balanced Technology, which includes synthetic products that can be applied at very low rates, says Bell, which means they "have a lot lower impact on the environment."

Another benefit is fewer days from application to harvest, notes Janet Porchak, marketing manager of UAP Canada. "You could have a crop where you've got an excellent product, but you can't spray it a certain number of days to harvest. Some of these products you can spray the day of harvest. When you're dealing with a horticultural crop like potatoes where you may not be spraying, but want people in [your field] scouting, there's another benefit."

Andrew Dornan, senior field development representative for Bayer CropScience Horticultural Products, says, "We are seeing conventional growers adopt both biorational and the new conventional chemistry in a programmed approach to pest control. The biorational products are fitting very well at certain times during the season where pest pressures tend to be lower and can potentially replace one or two conventional sprays."

With the Bayer CropScience acquisition of AgraQuest, it also acquired the Requiem line of synthetic insecticides, which is actually derived from a natural source. Requiem, a foliar application, targets all life cycle stages of sucking pests, from larvae to adults, and its active ingredient is a synthetic version of a biochemical originally found in an insecticidal plant. "The fit for Requiem in potatoes may be potato psyllid, which has yet to become a significant pest in potatoes in Canada, but is certainly a threat," Dornan says.

However, Requiem isn't yet registered for use in Canada. Dornan says Bayer CropScience is hoping to have Requiem approved for Canadian use in the near future. "There is progress, it's kind of like baby steps. We have to be able to show the grower the benefit of using the product," he says. "As long as growers keep seeing beneficial results, we'll continue to see adoption of these products."

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Photo courtesy of Bayer CropScience.

A Bayer CropScience scientist employs a fermentation device at the company's R&D biological products lab in Davis, Calif. Fermentation is the process by which biological products are produced for agriculture, much like making beer.

David De Koeyer, research scientist at Agriculture and Agri-Food Canada's Potato Research Centre in New Brunswick, says biorational insecticides have a lot of potential as research uncovers new ways of combatting potato insects naturally. De Koeyer has examined wild potatoes and their natural resistance to the Colorado potato beetle — a resistance not present in conventional potato varieties.

"We've studied some of these wild species that have insect resistance and profiled their chemical composition, with the goal of being able to improve the breeding process so we know which chemicals are responsible for that resistance," he says. "If we were able to identify and isolate such a compound, it could potentially have use in other applications, like a bioinsecticide."

De Koeyer notes that growing potato varieties with better genetic resistance to diseases and pests will also make using biorational products a more feasible option for growers. "Agriculture and Agri-Food Canada is developing potato germplasm with improved disease and pest resistance which will fit nicely into potato production systems with reduced environmental impact," he says.

Stoneman notes that due to the fact that biological ingredients are derived from completely natural sources, developing new biorational products is significantly more economical than developing new synthetics — making biorationals ideally suited to research and development.

"New chemistries are very costly to bring to market. It's somewhere in the order of $300 million to develop a new active ingredient [for a synthetic product]," says Stoneman. "In our sector, it's somewhere in the $2 million to $5 million range, depending on the company and complexity of the product. So you've got a distinct advantage in terms of development of new active biological materials entering the marketplace."

Marc Zienkiewicz

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EQUIPMENT & TECHNOLOGY SHOWCASE

Looking for new ways to protect your potato crop from disease and insects this season? *Spud Smart* has the details on some new products to help Canadian growers.

FOLIAR FUNGICIDE

EARLY BLIGHT and brown leaf spot have recently become less sensitive to existing Group 11 and other Group 7 fungicides in North America, leaving potato growers with fewer effective options. Luna Tranquility, a fungicide already trusted by apple and grape growers, now offers potato growers an effective alternative to control these diseases as part of a responsible resistance management program.

Bayer CropScience recently received registration for Luna Tranquility as a foliar fungicide for potatoes. Unlike any other previous fungicides, Luna Tranquility is a distinctive co-formulation that includes new and unique Group 7 (fluopyram) and proven Group 9 (pyrimethanil) modes of action, which provided superior control of early blight, brown leaf spot and white mold in field trials. The fungicide, which can be applied by either ground or air, also demonstrated effective protection against black dot.

Alberta agronomist Lindsay Fletcher of Crop Production Services, who participated in the field trials, found Luna Tranquility to be great at combating yield-reducing diseases, adding that it was "nice to have a chemistry that controls both parts of *Alternaria spp.*" Fletcher also noted that the unique chemistry behind Luna Tranquility could offer growers an effective resistance management tool.

Serenade Soil, another new potato product from Bayer CropScience available in 2014, is a biological fungicide that protects against soil diseases like rhizoctonia and pythium. Used as an in-furrow application, Serenade Soil builds a disease protection zone around the seed and roots. The liquid biological fungicide is exempt from tolerances and has a unique mode of action (Group 44) that assists with resistance management.

For more information, visit cropscience.bayer.ca.

SEED TREATMENT

SYNGENTA'S Cruiser Maxx Potato Extreme seed treatment has been registered for use on potato crops in Canada. According to the company, the enhanced, all-in-one, liquid pre-mix delivers a concentrated formulation that is simple and convenient to use and provides reliable protection from seed-borne diseases and early-season insects.

"With the launch of Cruiser Maxx Potato Extreme, Syngenta continues its commitment to bringing high-quality Seedcare options to growers," says Nathan Klages, product lead, Seedcare, for Syngenta Canada. "This new liquid pre-mix formulation provides growers with the ability to target both disease and insect pests with one product and the new concentrated formulation facilitates ease of mixing and measuring with fewer jugs to handle."

Chris Denys, Syngenta's Seedcare technical lead for Eastern Canada, agrees. "We've had people talk about the number of jugs they've had to throw away at the end of the year. They're pleased that they're going to have less of that to deal with," he says, adding that the new seed treatment's all-in-one formulation makes it easier for growers to use. "Now [they] have one calculation to figure out for one product."

Cruiser Maxx Potato Extreme contains three active ingredients for comprehensive control. Group 4 insecticide, thiamethoxam, works systemically to provide broad-spectrum performance. In the plant, it is translocated via the plant's water-conducting system where it remains active for up to 100 days.

Cruiser Maxx Potato Extreme also provides two modes of action against disease — an important feature now that some strains of seed-borne fusarium are resistant to thiophanate-methyl and fludioxonil. The combination of Group 3 fungicide, difenoconazole, and Group 12 fungicide, fludioxonil, offer a broad spectrum of control, including protection from silver scurf, rhizoctonia control, and a second mode of action against resistant fusarium.

For more information, visit syngentafarm.ca.

For more information on the products listed or to submit new E&T product offerings, email Mark Halsall at mhalsall@issuesink.com.

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ROUNDTABLE

Successful growers from across the country share their thoughts on Best Management Practices in potato production.

BMPs for Potato Fertilization

CHAD BERRY
One of the owners of Over and Under the Hill Farms in Glenboro, Man., Berry has been growing potatoes for 18 years. He farms 1,600 acres of processing potatoes.

BILL VASILY
The manager of C and V Farms in Alliston, Ont., Vasily farms 300 acres of table stock potatoes. He's been growing potatoes a long time — 32 years — but in his words, "I'm still learning."

CARL STEPHENSON
Stephenson runs Stephenson Farms Ltd. along with his brother Robert. They grow 200 acres of processing potatoes at their operation located in the Florenceville-Bristol area, in the heart of New Brunswick's potato belt.

We are pleased to present the second edition of ROUNDTABLE, *Spud Smart*'s special series in which we ask growers from different regions of the country for their insights and opinions on Best Management Practices in potato production. Planting season is almost upon us, so we thought growers would benefit from knowing tricks of the trade from other farmers for fertilizing potatoes and getting the 2014 crop off to the best start.

We posed the question of BMPs for potato fertilization to three growers from across the country: Manitoba's Chad Berry, Bill Vasily of Ontario and New Brunswick's Carl Stephenson. Here are their views on the best of the BMPs.

Soil and Tissue Testing

Stephenson maintains it's important to do the diagnostic legwork, in the form of soil testing and plant tissue tests, to ensure the right nutrients are being applied in the right amounts and at the right times each year. To this end, an initial soil test is good way to get your plants off to a good start.

"First of all, you need a good soil analysis to make sure everything is up to snuff on your ground," he says. This year, Stephenson plans to do soil testing using a grid pattern on a portion of his potato acreage, to help identify which areas of the field may need more nutrients, and which ones less.

"That's going to be something I'm going to implement into my fertilization this coming spring.... I think I'm going to be able to save in the long run," he says.

"When we go to lime, there are places that won't need any lime applied in certain areas of the field, and others that might take 3,000 pounds [of lime] per acre," Stephenson says. "What's been done a lot in the past, is you just go and apply a standard [amount of lime] per acre on the whole farm. Well, there's part of the farm that [doesn't] need it. So hopefully this will pay off."

Stephenson said this new practice could also mean having to use less fertilizer when he applies his first nutrient mix at the start of the season. "I might be able to broadcast upfront some of my requirements for fertilizer, then I have to put less down the tube at planting time with my potato planter," he says. "I'm hoping to see some results from that in the next few years."

Vasily says he doesn't do as much soil testing as some potato producers, but a lot of that has to do with the type of ground he farms on. "I'm on a very sandy soil. I've been farming this soil for a long time, and every now and then I'll soil test, but ... after 30 years [the results are] almost identical, so you're really just monitoring pH of the soil," he says.

"But I do it every now and then just to keep an eye on what's happening with the nutrient levels."

Stephenson makes a point of ensuring his potato plants are checked regularly during the growing season. "I have petiole tests done every two weeks when the plants get to a certain stage.... It just lets me know what's going on in the field," he says.

"If we've had a significant amount of rain in the early part of the season, maybe the nitrogen level's not where it should be, so I can apply some more [nitrogen] in the sprayer."

Berry agrees that regular plant testing is an important BMP. "We petiole test every week and that's how we decide what we're putting on later in the season," he says. "You can put on an application that's going to meet the crop's need, and that's it."

Vasily says he'll do plant testing if there's a problem in the field but "I don't do it as much as I should, perhaps." He believes measures like petiole testing are "actually a very good thing to do" because they help growers "keep track of the nutrients that are in the plant."

Using Micronutrients

Berry says he uses foliar applications of micronutrients in-season to boost his crop's potential. This way, he says, you're using "just enough product," which not only saves money but also results in better yields and improved crop quality.

Vasily adds magnesium sulphate and the micronutrient zinc (in the form of zinc sulphate) to his blight spray mix during the season to supplement his fertility program. He also applies boron to the soil in the spring.

Stephenson believes zinc and boron are important micronutrients for potatoes, but in the past he's had difficulty getting just the right amount in his fertilizer mix.

"Previous to the last few years, if you wanted boron or zinc added to your fertilizer blend, it was kind of thrown into the mix," he says. "It was such a small amount that my agronomist and myself came to the conclusion that we didn't really think we were getting any advantage out of it."

Timing was also an issue. Stephenson says boron in particular is helpful in controlling hollow heart, and for this reason he'd been applying it foliarly to his plants in-season. However, the boron application had to be at a certain stage in the plant's growth, and getting the correct timing was tricky.

Stephenson says the fertilizer company he's working with now has come up with a new process "where every aspect of your fertilizer [applied at planting] should have a certain portion of your boron and zinc in it."

Stephenson plans to implement the new process this year. He doesn't know exactly how much it'll cost yet, but Stephenson figures it shouldn't be any more than what he's paid in the past to apply micronutrient foliar sprays in-season.

Application Methods

Berry uses variable rate fertilizer application as an upfront treatment prior to the growing season. "We use it to maximize yield and try to create a more uniform crop across the field," he says.

After this initial variable rate application, Berry will use a top-dressing on his potatoes in-season, followed fertigation for finishing.

Berry says spreading out his fertilizer applications at his irrigated farm helps reduce environmental impacts associated with runoff. "That's why some of the fertilizer will go on in the spring, some will go on at hilling time, and then the rest will go on through the pivots in-season," he says.

Many potato producers these days use broadcast fertilization methods, at least for some of their applications. Stephenson says some farmers in his area start their fertility program off with a broadcast potash application each fall or spring. "I usually haven't done that," he says. "Most of my [fertilizer] blend just goes right down with the planter at planting time."

Vasily doesn't use broadcast methods either. "I'm in the minority now, but I think the placement of the fertilizer is very important," he says. Vasily believes targeted fertilizer applications, unlike broadcast methods, put the nutrients where they're needed most.

"If it's broadcast, it can be too high, too low, too far into the middle of the row, and that type of thing," he says. "My placement is totally around the plant root zone. The fertilizer is put where the roots can access it the earliest, and also it's in that potato hill which protects it from leaching."

Vasily says his first fertilizer application is in the spring, "when we just go in with a planter to a pre-bedded fumigated sub-soiled hill. We apply the fertilizers through the season — there'll be the band at planting, there'll be a side-dress at hilling time, and then there'll be a top-dress before row closure, mostly nitrogen. So there's different layers of fertilizer, but all in the root zone, and there are different times of application." Vasily adds that with exception of micronutrients, granular fertilizer is used in all of soil nutrient applications.

Vasily acknowledges that one of the reasons broadcasting fertilizer has become so popular is the increasing size of farms. He's a 300-acre grower, while many of his counterparts are farming 1,000 acres or more of potatoes. With operations that size, time is usually of the essence.

"They want the speed so they're broadcasting fertilizers, whereas my method perhaps utilizes the fertilizer better," he says. With rising concerns over the impact of nitrogen runoff into streams and lakes and resulting algae blooms, Vasily forsees the day when farmers may be required to be much more conservative in their nutrient usage.

"I know it's going to be very hard to convince farmers not to broadcast fertilizer, but that's one of the biggest things, I think.... We're wasting nutrients with that method," he says. "I do think we have to learn how to use the least amount of these [fertilizers] and produce economic results.

"I think I'm already doing the best I can by putting [the fertilizer] where it can be utilized most efficiently," says Vasily. "I honestly can't think of a better way to do it with the acreage I'm running."

eye on the nation

QUEBEC

By Clement LaLancette,
General Manager
Federation des Producteurs de Pommes de Terre du Quebec

In 2010, 2011 and 2012, Quebec potato producers participated in a project to determine the efficacy of using the Miléos forecasting model to control potato late blight disease (*Phytophthora infestans*), compared to preventative systematic fungicide treatments. The project was financed by the Canadian Agricultural Adaptation Program.

The Miléos model was developed by Arvalis, a French vegetal institute, and a French government agency as a way to better predict conditions where fungicide treatments to protect against potato late blight could be applied in an analytical, reasoned manner. This forecasting model is very thorough as it takes several factors into consideration, such as meteorological data (temperature, relative humidity, rainfall), plant variety sensitivity, planting and emergence date, plant growth (active, stabilized), the sanitary conditions around and within the plot (environmental data) and any interventions performed (fungicide treatments or irrigations).

This forecasting model equally integrates all aspects of the developmental biology of late blight. The compilation of all the data allows for the calculation of risk of disease development and treatment recommendations. Potato late blight disease is very aggressive and destructive, but several factors must occur in order for it to develop, including plants susceptible to attack, favourable climatic conditions and the presence of a virulent pathogenic agent.

Traditionally in Quebec, the control of potato late blight is based on a strategy of systematic fungicide treatments made every seven to 10 days, without considering the risks related to disease development. As such, growers could apply up to 12 fungicide treatments per season. In the spirit of sustainable development, such a strategy is difficult to justify. For economic, agronomic, environmental and public health reasons, the use of a forecasting model capable of reducing the number of fungicide applications appears to be an essential approach to evaluate and implement.

The results of this project demonstrate that depending on the weather conditions of the production season, it is possible to significantly reduce the number of treatments without affecting the yields. For participating growers in Quebec, using the Miléos model resulted in the reduction in the number of fungicide treatments by up to 80 per cent in one season.

At the onset of the study, participating growers learned to master the use of the Miléos model and to better understand how it functioned. At the beginning of the project, some growers were nervous at the idea of waiting more than seven days without treating, but they learned to trust the model's recommendations. After the first season, these same growers observed that the model was working and the majority adopted recommendations from the Miléos model in their own fields. In the mid-term, we hope to use the Miléos model with several growers in each of Quebec's potato-producing regions. We therefore believe that it is possible to use this model on a large scale in Quebec.

BRITISH COLUMBIA

By Tom Demma, General Manager
B.C. Vegetable Marketing Commission

At this time of year, British Columbia potato producers are engaged in activities that will position them for being ready for 2014 production and completing marketing of the 2013 storage crop.

The British Columbia 2013 crop is characterized as having average yield with excellent quality. There was good demand and good prices for the early potato crop, while potatoes now being sold from storage are also of excellent quality and are experiencing steady demand. When comparing prices at this time of the year to the same period last year, they are comparable or slightly better.

Producer decisions about varieties to plant in 2013 resulted in a slightly different crop make-up as red and yellow potato varieties appear to have been preferred over others. Nonetheless, white and Russet potatoes continue to command significant attention in the provincial potato planting mix.

It is too early to get overly enthused about what is ahead for the customary early white British Columbia potato crop. That's because as of early February, the weather had been unseasonably cold and there were no hints of spring evident. Whatever the weather vagaries might be, producers who normally plant early white potatoes are gearing up so to be ready to plant when the opportunity presents itself.

Overall, the 2013-14 crop year is characterized as favourable with most, if not all, producers enjoying reasonable returns for the volumes marketed.

NEW BRUNSWICK

By Matt Hemphill, Executive Director
Potatoes New Brunswick

New Brunswick's 2013 potato crop is storing very well. The quality of potatoes for processing is consistent with an average year and holdings in the province is on par with other years. The fresh crop is also cleaning up well. Although holdings are below the previous year, it is mainly due to fewer acres being planted to fresh in the province in 2013.

Fresh packers are investing in technology to combat typical defects in potatoes such as hollow heart. This investment allows New Brunswick packers to put the best possible product into retail stores for our customers.

Seed quality in New Brunswick has never been better. New Brunswick continues to lead the industry on PVY management. More than 95 per cent of our seed this year tested below three per cent for PVY! This is something we are extremely proud of as people in our industry pulled together to make it happen and we will continue to strive for excellence in seed production. Potatoes New Brunswick along with our seed organization, the New Brunswick Seed Potato Growers Association, held our annual PVY workshop in February. This workshop pulls together the industry to present, discuss, and challenge each other in an attempt to get better at PVY management. This year we accomplished just that!

Potatoes New Brunswick held its annual potato conference and trade show on Feb. 6 to a packed house in Grand Falls. The list of speakers included Maureen Storey from the Alliance for Potato Research and Education as well as provincial and federal government researchers and more.

Potatoes New Brunswick also presented updates on research projects such as our drone technology project, and announced a new four-year agronomy project that will study all aspects related to increasing yields. The main focus of this project will be the four verticals of potato production: soil and water management, seed improvements, science and technology, and economics.

MANITOBA

By Dan Sawatzky, Manager
Keystone Potato Producers Association

Spring brings with it optimism and anticipation of the coming growing season. Winter's grip in Manitoba has been tight with the second coldest December recorded since 1893 and headlines in mid-February suggesting this winter may also be one of the coldest in recent history. The cold coupled with above-average snowfall leaves us beginning to wonder if spring will be delayed, as it was in 2013. The cold has created challenges and costs associated with the storage of potatoes.

Our inventory is high in both the fresh and processing sectors. Seed sales have also been sluggish, reflecting notification of volume uncertainty and reductions by the processors. The majority of surplus production from the 2013 crop has been spoken for, with about 350,000 hundredweight still open.

Growers must once again attempt to plant according to their land's productivity to bring provincial supply in line with demand. Improved water management and land selection have contributed to an escalating yield trend. Continued research and education are also contributing to improved levels of management, translating into increased yields.

Manitoba Potato Production Days, held in Brandon during the last week of January, saw record attendance. A number of knowledgeable speakers presented on topics related to potato agronomy. The United Potato Grower Partners meeting held on Feb. 26 garnered a lot of interest. Our annual spring production meeting scheduled for April 8 will highlight Manitoba potato research with reports from those involved in private, university, provincial and federal government research projects. Information and updates will also be provided by affiliated entities.

eye on the nation

PRINCE EDWARD ISLAND

By Gary Linkletter, Chairman
Prince Edward Island Potato Board

Many people in the non-farming community are under the impression that winter is a fairly relaxed season for potato farmers. However, as all of us in the industry are well aware, nothing could be further from the truth. Between updating our certifications for programs such as food safety and pesticide application, business planning, getting our crop to market and attending grower information sessions, winter is extremely busy.

In Prince Edward Island this season, producers have had many excellent educational opportunities. One of the hot button topics in our industry these days is how we are going to contain the threat posed by wireworm. A grower information day was held in Charlottetown in early February and was well attended by growers from across the province. A wide range of topics was covered by presentations on the biology of this pest as well as details on ongoing research projects looking at various control measures and strategies that growers can now use, including rotation crops, tillage and chemistry to start to reduce or maintain low levels of wireworm in potato fields. It will take time and innovation to build an effective control strategy when dealing with such a hardy soil-borne pest with a long life cycle.

The International Potato Technology Expo, held every two years in Charlottetown, took place on Feb. 21 and 22. Once again this provided an excellent forum for growers to gather and learn about the latest in products and machinery that are available to us to help us grow in a profitable manner. The breakfast session covered results from research into the physiological age of seed and how this affects resulting tuber size and number, an update from Farm Credit Canada, and a series of presentations on the progress potato farmers in P.E.I. are making in the area of environmental stewardship. The trade show provided displays on the latest in potato varieties, potato handling equipment, information technology products, etc.

There's been many other workshops over the winter season, sponsored by such groups as the United Potato Growers of Canada, the P.E.I. Soil and Crop Improvement Association, and the Federation of Agriculture and product suppliers, to name a few. Chances to see the latest advancements and discuss new products and developments with other producers helps to keep our farms in the forefront.

ALBERTA

By Terence Hochstein,
Executive Director
Potato Growers of Alberta

Alberta continues to have a good winter in regard to tubers maintaining their quality in storage. Considering that growers in the south had to deal with their fair share of late blight this past summer, there has been very little ill effect to the tubers currently in storage. The diligent practices that the growers underwent during the growing season and into harvest seem to be paying huge dividends in regards to delivering top quality potatoes to the processors.

Prior to our spring area meetings in mid-March, Potato Growers of Alberta held what we hope will be an annual event. Part 1 in a three-part speaker series on late blight was held in two sessions, Feb. 26 in Taber and Feb. 28 in Edmonton. The focus of this forum is to increase awareness and knowledge about late blight to enhance Alberta's seed potato industry.

Part 1 of this late blight speaker series included presentations from Michael Harding and Ron Howard of Alberta Agriculture and Rural Development, and Larry Kawchuk and Rick Peters of Agriculture and Agri-Food Canada. Part 2 will be in early June, featuring a presentation from Phil Hamm of Oregon State University, while Part 3 will be featured at our annual general meeting in Red Deer in November. We are planning to continue this forum each year, to give all the growers and industry representatives an opportunity to obtain all the latest information on relevant topics chosen for each series.

Contract negotiations are now underway across North America and the underlying tone this year is better efficiencies and increased yields, while at the same time decreasing grower costs. It is great to see the camaraderie amongst the different growing areas of North America as we all begin one of the toughest, yet rewarding, aspects of our industry.

As we all wait for the snow to melt and winter to leave us behind, we hope for another spring of warm temperatures and look forward to the prospect of another successful year. Where else but in agriculture can you start each year with a whole new set of game plans and a renewed sense of optimism?

POTATO NEWS YOU CAN USE

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SPUDSMART MAGAZINE

Boosting Fertility Through Testing

Petiole and leaf tissue analysis represent important tools in fertility management of potato crops.

By Lukie Pieterse

Lukie Pieterse is a consultant and writer with decades of experience in the potato sector, from growing his own drip-irrigated potatoes to writing international potato news. Tuber Talk is an insider's take on the issues impacting the industry.

NEW ADVANCES IN tissue analysis of potato crops could give growers an early warning of nutrient deficits that could be impinging on yield potential — as well as allow them sufficient time to take remedial action, according to Jez Wardman, a plant nutrition specialist at fertilizer company Yara UK.

"While soil analysis can help identify potential issues and plan fertilizer programs," he says, "petiole or leaf tissue analysis is a far more effective agronomic tool to tailor in-season inputs."

Kyra Stiles, agri-environmental development co-ordinator at the Prince Edward Island Department of Agriculture and Forestry, agrees that tissue sampling can help to identify in-season crop growth limitations related to nutrient deficiencies or toxicities.

"The tissue analysis indicates what the plant was able to take up from the soil, but does not reflect what nutrients are present in the soil supply," she says. "Referring to a recent soil sample taken or collecting a soil sample at the same time of tissue sampling, will add to the interpretation of the tissue analysis by giving an indication of the supply of nutrients within the soil."

For most of the micronutrients that are critical to the plant's growth, research has pinpointed the peak demand is from 20 to 60 days after emergence; for tuber formation, that demand increases to 90 days. "If it cannot get the required nutrient on the day that it is needed, it will be subjected to stress that starts to limit potential for final yield and tuber quality," Wardman warns.

Wardman points to the importance of certain nutrients for specific potato-related characteristics:

- Influencing dry matter content — nitrogen, potassium, magnesium
- Influencing starch content — nitrogen, phosphate
- Reducing internal spotting — calcium, boron
- Improving skin finish — calcium, sulphur, boron, zinc
- Reducing potato bruising — potassium, calcium, boron
- Reducing tuber discolouration — potassium, magnesium, boron

"WHILE SOIL ANALYSIS CAN HELP IDENTIFY POTENTIAL ISSUES AND PLAN FERTILIZER PROGRAMS, PETIOLE OR LEAF TISSUE ANALYSIS IS A FAR MORE EFFECTIVE AGRONOMIC TOOL TO TAILOR IN-SEASON INPUTS."

JEZ WARDMAN

Wardman notes that if growers start to see symptoms that indicate a deficiency of one or more nutrients, the adverse impact on yield and quality will already have taken place. According to him, the actual nutrient uptake and utilization by potato plants could be far in excess of the so-called crop requirement. As an example, he points out that for boron, the crop required four times as much for healthy development during growth than would finally be removed.

Although it is often too late to reverse the effect of nutrient deficiency on the crop's yield for the season when a crop begins to display visual nutrient deficiency symptoms, it may provide a better indication of how to prevent these deficiencies within future crops, according to Stiles.

Photo courtesy of Jez Wardman, Yara UK.

A side-by-side comparison illustrates the importance of nutrition in potato development. From left to right: 1) plant with balanced nutrition, 2) plant with magnesium deficit, 3) plant with boron deficit, and 4) plant with sulphur deficit.

Tissue Test Timing

Wardman advocates that tissue analysis should ideally be taken within 30 days of plant emergence to enable any remedial action. "Petiole analysis is regarded as more accurate early in the season, whereas leaf analysis tends to be later in the season," he advises. "The recommendation for petiole analysis is to sample the fourth petiole from the top of the plant, so this will need to be a couple of weeks after emergence."

However, Wardman acknowledged that with continual uptake and movement of different nutrients within the plant according to climatic conditions and growth stage, the results always require appropriate interpretation.

Many factors play an important role in tissue sampling, according to Stiles. "Sampling the appropriate plant part at the appropriate growth stage, based on the crop, is crucial in determining accurate nutrient concentrations within the plant."

"SAMPLING THE APPROPRIATE PLANT PART AT THE APPROPRIATE GROWTH STAGE, BASED ON THE CROP, IS CRUCIAL IN DETERMINING ACCURATE NUTRIENT CONCENTRATIONS WITHIN THE PLANT."

KYRA STILES

Stiles points out that depending on the crop, different areas of the plant (such as older tissues versus juvenile tissues) can range in nutrient concentrations, as some nutrients are less mobile within the plant, or are stored in various plants parts. Sampling the wrong plant tissues can skew the nutrient analysis, and give imprecise results.

Stiles says correct procedures need to be followed when taking samples from the field for analysis. Firstly, when preparing to collect tissue samples from your field, growers should always refer to

GENERALLY, THE AMOUNT AND VALUE OF INFORMATION OBTAINED FROM TISSUE ANALYSIS WILL BE DIRECTLY RELATED TO THE EFFORT AND ATTENTION PUT INTO THE SAMPLING. IT'S IMPORTANT TO KEEP IN MIND THAT TISSUE ANALYSIS IS NEITHER FOOLPROOF NOR ALL-INCLUSIVE.

their analytical lab for the correct sampling protocol for your tissue analysis, she says.

In general, potato tissue sampling should begin at the flowering stage (often 40 to 45 days after planting) and can be repeated frequently throughout the season, based on desired sampling objectives.

"Samples should be collected from the first fully matured leaf (often the fourth leaf from the top of the plant), and stripped of the leaflets with only the main stem remaining," Stiles says. "Samples should be collected in a zig-zag pattern across the field to provide a representative composite sample from the entire field."

To have a consistent sampling technique, growers should take a petiole from the same location on the plant each time the field is sampled. Stiles recommends that approximately 100 grams of petioles (the equivalent of approximately 60 to 80 petioles dependent on the growth stage of the plant) should be collected to provide adequate material for lab analysis.

WHERE ON THE WEB

The P.E.I. Analytical Laboratory provides a potato tissue sampling protocol. Growers can download a copy of their factsheet, *The Why and How of Potato Tissue Testing*, which includes detailed instructions on proper tissue collection, at **goo.gl/LbEJhq.**

If there are specific areas of the field that are not consistent with the majority of the field, these areas should be avoided and sampling should be done separately from the whole field analysis, she says. Problem areas should be sampled and analyzed separately to provide better insight into particular nutrient deficiencies, diseases or stressors that may have had an effect on the crop within these areas.

Storing Test Samples

Stiles adds petioles should be stored in a small paper bag in a cool, dry place, and brought to the lab the same day for analysis. Bags should be properly labelled with the sample identification

Introducing new Tricor DF. Broadleaf weed control for Canadian potato growers.

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name or number, grower name, date of sampling, and growth stage of the plant.

Stiles also points out that it is essential to ensure that the integrity of the tissue samples are maintained from the point of tissue sampling until they are brought into the analytical lab. Samples should be clean and dry, and kept cool to prevent any damage to the sample during travel, which could have an effect on the results of the tissue analysis. If samples are not taken and handled properly, the results may be incorrect and may influence proper fertility recommendations, she adds.

"Samples should be submitted for analysis on the same day they are taken," Stiles says. "If multiple tissue samples will be taken over time, the time of day in which they are taken should remain consistent as the movement of nutrients in the plant can vary throughout a day and can thereby influence results."

Generally, the amount and value of information obtained from tissue analysis will be directly related to the effort and attention put into the sampling. It's important to keep in mind that tissue analysis is neither foolproof nor all-inclusive. Growers should not expect all their questions to be answered with a single tissue sample.

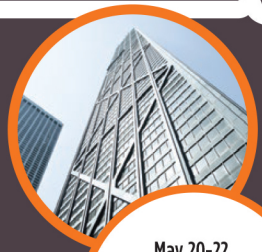
SPUD CALENDAR

UPCOMING EVENTS, CONFERENCES AND TRADE SHOWS IN YOUR REGION AND AROUND THE WORLD. MORE EVENT LISTINGS ARE AVAILABLE AT SPUDSMART.COM.

April 8
Keystone Potato Producers Association 2014 Spring Production Meeting
Portage la Prairie, Man.

June 25-27
National Potato Council 2014 Summer Meeting
Sun Valley, Idaho

July 13-15
Potato Marketing Association of North America 2014 Summer Meeting
Charlottetown, P.E.I.



July 6-11
European Association for Potato Research Triennial Conference
Brussels, Belgium

May 20-22
National Confectioners Association Sweets and Snacks Expo 2014
Chicago, Ill.

May 8-14
Interpack 2014
Dusseldorf, Germany

EUROPE

IF YOU HAVE AN UPCOMING EVENT YOU'D LIKE TO PUBLICIZE, EMAIL *SPUD SMART* EDITOR MARK HALSALL AT MHALSALL@ISSUESINK.COM.

MARKET**NEWS**

The number of potatoes in storage is close to what it was last year at this time in the East, but it's up in the West, primarily due to an increase in process potato holdings.

Storage holdings up 4.1 per cent

MARCH NUMBERS for Canada's storage holdings from the United Potato Growers of Canada are showing an increase from the same period in 2013.

"In the East it's basically the same as it was a year ago, and in the West it's up significantly, almost 10 per cent," says Kevin MacIsaac, general manager of UPGC. "That's related to above-average yields to start with, in Manitoba and certainly in Alberta."

MacIsaac points to movement as another factor. The fact that some Western processing plants temporarily shut down over the holiday season "probably slowed down the processing a little bit," he says.

It's in the processing category where you'll find the majority of extra potatoes in Western Canada, MacIsaac says. "Some of those potatoes are in addition to contract volumes that growers have, so they'll need to find a home."

MacIsaac doesn't think this will be an issue, "but it will mean that the processors will be able to run longer on Canadian potatoes than they did last year for example, or in previous years where they had to bring potatoes in from the U.S. That'll mean a longer frying season, I believe."

THE PACE of potato shipments has generally been good across Canada.

"Movement overall in the country is better than a year ago, and it's probably one of our highest movements, I would say, in about four years," says MacIsaac. "Normally, right after Christmas it tends to slow down and this year it seemed to keep moving into January, so that's good. It was a good month."

MacIsaac says this development wasn't expected. "It surprised us," he says. "We expected it to slow down a little bit, but it didn't. It just seems to be that demand is there for the product. And of course, when we started out in the season, the pipeline was not full, so that's helped. You're speeding into a vacuum so if it's empty to start with, you tend to have more momentum longer through the year."

Canadian Potato Storage Holdings by Province (000 cwt)

Province	March 1, 2014 Holdings	March 1, 2013 Holdings	Difference	% Change
P.E.I.	13162	13620	-458	-3.4
New Brunswick	6784	7226	-442	-6.1
Quebec	5488	5098	390	7.7
Ontario	3275	2683	592	22.1
Eastern Canada	28709	28627	82	0.3
Manitoba	11739	10193	1546	15.2
Saskatchewan	n/a	n/a	n/a	n/a
Alberta	9841	9403	438	4.7
B.C.	369	460	-91	-19.8
Western Canada	21949	20056	1893	9.4
Total Canada	50658	48682	1976	4.1

Source: United Potato Growers of Canada

"THE LONG RANGE EXPECTATION NOW IS THAT, BY THE WAY MOVEMENT HAS GONE, THERE COULD ACTUALLY BE A LITTLE BIT OF A HOCKEY STICK, WHICH MEANS THAT MARKET DEMAND EXCEEDS THE SUPPLY AT THE END OF THE SEASON. THAT'S WHAT SOME OF THE PEOPLE WHO ARE KNOWLEDGEABLE IN THE BUSINESS ARE SAYING COULD HAPPEN."

Kevin MacIsaac, general manager of UPGC

WHILE THERE are some areas of the U.S. where pricing could be higher, the pricing picture in Canada is generally good, MacIsaac says, particularly on the fresh side.

"The long range expectation now is that, by the way movement has gone, there could actually be a little bit of a hockey stick, which means that market demand exceeds the supply at the end of the season," he says. "That's what some of the people who are knowledgeable in the business are saying could happen."

MacIsaac says that could result in a similar situation to what happened last year, when prices went up substantially at the end of the season.

Market information courtesy of the UPGC, UPGA and iindustry partners, and Bruce Huffaker, market analyst and publisher of *North American Potato Market News*.

THE UNITED STATES exported 10.16 million hundredweight of fresh potatoes in 2013, a 7.2 per cent increase from 2012 and the largest export figure in North American Potato Market News records that date back to 1991. According to NAPMN publisher Bruce Huffaker, Canada took 95.4 per cent of the extra potatoes shipped in 2013, and 56.5 of all the fresh potatoes the U.S. exported last year. In 2012, Canada's share of this U.S. export market was only 53.7 per cent.

In February, fresh potato shipments in the United States were down two per cent, or 128,000 hundredweight, from the same period in 2013, says Huffaker, adding that a 166,000-hundredweight drop in Idaho shipments is responsible for the entire decline.

▲ 7.2% EXPORT INCREASE

▼ 2% DECREASE IN FRESH POTATO SHIPMENTS

DURING 2013, the global trade in potato flakes fell 4.3 per cent short of the 2012 pace. According to Huffaker, the major factor in this decline was a drop in United States imports of potato flakes from the European Union. The United States remains the world's second largest potato flake importer, in spite of a 36.4 per cent drop in its 2013 imports.

Canada exported 17.4 million pounds of potato flakes in 2013, says Huffaker, with almost 85 per cent of this product going to the United States.

The European Union and the US dominate the global market for potato flakes. More than 99 per cent of all international trade in potato flakes originates from those two regions, Huffaker reports. European sales have grown rapidly since 2002, while U.S. exports have risen more slowly.

World Review

NEWS & INSIGHTS FROM AROUND THE GLOBE.

Photos courtesy of Khalil Al-Mughrabi, New Brunswick DAAF.

New Dutch study on late blight resistance.

The Netherlands

PHYTOPATHOLOGISTS at Wageningen University in the Netherlands have discovered a new mechanism that increases the resistance of potatoes to *Phytophthora infestans*, which causes late blight in potatoes. The new kind of resistance is based on the protein LecRK-I.9 and operates on the outside of the plant cell. This is new, because the resistance used so far to help potatoes withstand *Phytophthora* recognizes unwanted intruders in the plant cell. But this kind of resistance is relatively easy to circumvent because *Phytophthora* mutates rapidly and can therefore avoid being recognized.

Phytopathologist Klaas Bouwmeester came across LecRK in Arabidopsis, a plant Wageningen scientists often use for research. He demonstrated earlier that this protein plays a role in the resistance of Arabidopsis to plant diseases. Bouwmeester then placed LecRK in potatoes, demonstrating that these potatoes have an increased resistance to Phytophthora, as he explains in the January edition of the *Plant Biotechnology Journal*.

That does not mean there is now a potato variety with long-lasting resistance to the potato disease, says Bouwmeester. In 2013 he was awarded a grant from the Dutch Organization for Scientific Research to investigate this new kind of resistance further. He is looking for similar proteins in potatoes, as well as in tomatoes and chili peppers. Bouwmeester will examine how these proteins function in order to find the versions that give maximum resistance in these crops.

"If that works, it would be a good idea to combine this new kind of resistance with the familiar resistance proteins in the plant cell," says Bouwmeester. "In that way, we create two lines of defence against *Phytophthora*."

Source: Wageningen University

Turkey

AS part of the zero-waste commitment for its manufacturing operation, PepsiCo's agriculture team in Turkey invested in anaerobic digestion technology several years ago to handle the organic waste created there. Known as a biodigester, the system is fed by a mixture of potato peels, corn kernels and other ingredients used in the company's snack foods.

Today, the biogas generated by that equipment generates approximately 35 per cent of the electricity needed to run PepsiCo's two Frito-Lay snack food plants in Turkey. Researchers also figured out a way to turn the nutrient-rich material created in this process into a more environmentally friendly fertilizer, which it is now supplied to its more than 350 contract farmers in the country.

The idea resulted from a collaboration between the manufacturing team, which was trying to find a better way to dispose of the biological waste, and PepsiCo agricultural advisors, who were trying to reduce the negative impact of soil additives used to grow potatoes.

"As the team was thinking about what to do with the sludge, another team was looking for new fertilizer approaches that were more sustainable," says Ece Aksel, general manager of PepsiCo Turkey. "Together, they found this process."

The pilot test began roughly two years ago, when the organization began working

with prominent scientists to come up with a natural fertilizer formulation beneficial for potato crops. The result is an organic meal that comes in pellet form. To produce the substance, the PepsiCo plants ship the sludge to an external partner, which composts it for about three weeks to dry it out. Next, nutrients are added and the pellets are produced, packed into bags and shipped to farmers.

According to Aksel, this approach helped the plants reduce the operations costs related to the biodigester, and less chemical fertilizer is required for use on farms.That balance was necessary to greenlight the project. "It is imperative that … we ensure that our company is financially successful and environmentally responsible at the same time," she says.

Source: Greenbiz.com

Kenya

AS a contribution to the Consultative Group on International Agricultural Research Humidtropics Research Program, the International Potato Centre (CIP) has a research team in Kenya studying heat-tolerant potato clones. The CIP-Humidtropics research project also works on the training of farmers in western Kenya, where the farm-based trial is taking place.

Started in 2013, the CIP-Humidtropics research focuses on the important issue of crop diversification. In western Kenya, diversification helps to reduce dependence on corn — a principal cash crop in the region — as well as to mitigate the effects of the corn lethal necrosis virus, through the introduction of potato as a rotation crop. As a result of a decline in yields in both corn and beans, Kenyan farmers are now looking for an alternative food crop to supplement what they have.

In response to this demand, CIP is evaluating 16 heat-tolerant potato clones in the western Kenya region to determine which ones are best suited to local conditions. The research team includes scientists and potato breeders from CIP and its partner organization, the Kenya Agricultural Research Institute. Farmers are a key part of the research project, working closely with the research and evaluation team throughout every step of the project.

Source: cipotato.org

AT THE root

POTATO PEOPLE, PRODUCT AND BUSINESS NEWS YOU NEED TO KNOW.

People News

KWS POTATO HIRES MANAGING DIRECTOR

KWS has appointed Roland Peerenboom as managing director of KWS Potato B.V. based at the company's new facilities located in Nagele, Flevoland, in the Netherlands. Peerenboom most recently worked for Greenport Holland International as director and program manager for China and India, focusing on the international business development for the Dutch horticultural industry.

Product News

BASF OFFERS NEW HERBICIDE

BASF Canada Inc. has received regulatory approval for Outlook, a new herbicide that will help potato growers address a major challenge to ag production — the increasing variability in the amount and timing or rainfall. According to the company, Outlook will provide consistent control of nightshade, pigweed and annual grasses, even under dry conditions. As a Group 15 herbicide, Outlook also controls both triazine and Group 2 resistant biotypes whose populations continue to increase across the country.

PARSNIP CHIPS NEW SNACK FOOD OPTION

In response to increased consumer demand for unique snack food options, Naturally Homegrown Foods has introduced Hardbite Parsnip Chips. The firm based in Maple Ridge, B.C. launched the new product at the Natural Products West Expo in Anaheim, Calif., in March. Made from fresh parsnips (root vegetables closely related to carrots), Hardbite Parsnip Chips are billed as "subtlety sweet and crunchy snacks ideal for the sophisticated snacking experience."

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2 resistant biotypes whose populations continue to increase across the country.

Business News

IDAHO GROWERS REACH AGREEMENT WITH MCCAIN

Idaho potato growers who sell to McCain Foods have agreed to a contract that maintains roughly the same pricing as last season, says Dan Hargraves, who negotiated on their behalf as executive director of Southern Idaho Potato Cooperative. A majority of SIPCO's growers approved the contract during a March 3 meeting in Burley, Idaho.

LOGAN FARM EQUIPMENT LAUNCHES WEBSITE

Logan Farm Equipment, a leading manufacturer of potato equipment, has announced the release of the company's new and improved, user-friendly website. "Our company is committed to providing durable, purpose-built potato equipment. We are pleased to have a website that reflects the quality of our product and showcases our equipment with all their full features and benefits," says Clinton Arnold, director of sales for Logan Farm Equipment.

W.P. GRIFFIN INVESTS IN NEW POTATO EQUIPMENT

W.P. Griffin is receiving a combined investment of $372,490 from the Prince Edward Island provincial government and Canada's federal government to purchase new weighing and bagging equipment. The Government of Canada is investing a total of $323,490 for the equipment and also to help W.P. Griffin market its product and expand its exporting capabilities. The P.E.I. government is investing a total of $49,000 towards the purchase of new equipment.

RWL HOLDINGS ADDS NEW POTATO EQUIPMENT

The Government of Prince Edward Island has announced an investment of $569,000 for RWL Holdings Ltd. to purchase innovative, technologically advanced equipment for a high-speed potato wash facility. This new optical-sensing sorting equipment allows RWL Holdings to offer a new service to P.E.I. potato growers by providing them with a high-speed, high-volume service that will help increase their profitability by offering a more consistent product.

BAYER POTATO PERSPECTIVES SURVEY

Bayer CropScience launched its Potato Perspectives Survey during Potato Expo held in January in San Antonio, Texas. Bayer collected valuable insights from attendees across the food chain

to identify potato trends, opportunities and challenges as the industry prepares for the 2014 season. Key findings include:

- 48 per cent of potato grower participants responded that early blight and white mould were the most difficult diseases to control during 2013.
- 63 per cent of potato grower participants pinpointed the reduction of yield and quality loss due to insects and disease as a critical need to ensure a successful harvest this season.
- 42 per cent of grower participants believed biotechnology may be able to expand production capabilities and crop yield for the potato market.

Industry News

CHC RECEIVES BOOST FOR FURTHER RESEARCH

The Canadian government is investing $7 million to support a new research cluster led by the Canadian Horticultural Council. The investment will support industry experts, scientists and academics conducting research focused on reducing crop input costs while improving marketable yield and margins for apple and potato growers. CHC is also receiving further funding via the AgriMarketing Program for an additional project that will also benefit the potato industry. The funding will allow the CHC to work on issues affecting market access for potato farmers and to increase global awareness of Canadian potatoes. "Our government remains focused on the economy and on creating opportunities for Canadian farmers and businesses to grow and prosper," says Agriculture Minister Gerry Ritz. "A strong partnership between government, industry and academia will help ensure continued innovation and commercialization within Canada's vibrant and diverse horticulture sector."

RESEARCH SHOWS GM SPUDS BEAT BLIGHT

United Kingdom research findings recently published in the journal *Philosophical Transactions of the Royal Society* showed that genetically modified plants in the study were not infected by late blight. Funded by the Biotechnology and Biological Sciences Research Council and the Gatsby Foundation, the research indicated that in 2012, the third year of the trial, the potatoes experienced ideal conditions for late blight. None of the plants in the study were inoculated against late blight. According to researchers, transgenic Desiree plants were 100 per cent infected with late blight by early August of that year while all of the GM plants remained fully resistant to the end of the experiment.

PARTNERSHIP UNVEILS NEW VARIETIES

The Maine Potato Board and University of Maine have announced the creation of two new potato varieties targeted at the french fry and potato chip industries. The new varieties — the Easton and the Sebec — were developed over the past several growing seasons. "The Easton and Sebec varieties are the first to be

released by the University of Maine in the past decade, and the first varieties to be released in partnership with the Maine Potato Board," says Tim Hobbs, director of grower relations for the Maine Potato Board.

UNLOCKING SECRETS OF POTATO BLIGHT

Scientists have discovered vital clues as to how the pathogen responsible for the Irish potato famine adapted to spread between different plant species. Researchers at England's Oxford University and the Sainsbury Laboratory at Cambridge University looked in unprecedented detail at how *Phytophthora infestans*, a pathogen that continues to blight potatoes and tomatoes today, evolved to target other plants. The study, published in the journal *Science*, is the first to show how pathogens switch from targeting one species to another through changes at the molecular level.

POTATOES WILL MANAGE CLIMATE CHANGE PRESSURE

Research at the U.S. Department of Agriculture suggests that potatoes are still the go-to tuber when times get tough. David Fleisher, an agricultural engineer with the USDA's Agriculture Research Service, and colleagues conducted studies to measure how potato plants would respond to elevated atmospheric carbon dioxide levels and the increasingly erratic rainfall patterns expected to result from global climate change. Averaged across all drought treatments, tuber yield from plants growing under

elevated carbon dioxide levels was as much as 60 per cent greater than tuber yield from plants growing under current carbon dioxide levels. The study results have been published in the journal *Agricultural and Forest Meteorology*.

AMERICANS EATING MORE POTATOES

In a new survey by the Idaho Potato Commission, 97 per cent of Americans said they eat potatoes and more than 81 per cent enjoy them as a side dish, snack or main course on average of three days per week. "The Idaho Potato Commission's marketing programs have one main objective and that is to increase Idaho potato consumption nationwide," says Frank Muir, president and CEO of IPC. "We were thrilled with the survey results, which found consumer attitudes toward potatoes shifting. America's favourite vegetable is now consumed three times a week, up from two times per week in 2009."

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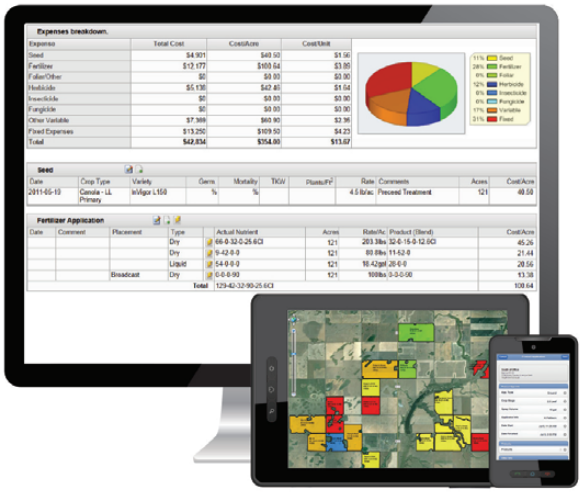

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THE AGRI-DATA® SOLUTION

Quebec Producers Renowned for Growing Yellow Potatoes

Photo courtesy of Maxi-Sol Inc.

Ninon Perreault and Francis Desrochers, co-owners of Quebec's Maxi-Sol Inc.

"Due to the consistent quality of our products, our company differentiates and increases its market share annually."

Francis Desrochers

THE POTATO GROWING operation Maxi-Sol Inc. is located in Saint-Paul de Joliette, Que., a 45-minute drive northeast of Montreal. Founded in February 2009, the company is co-owned and managed by Ninon Perreault and Francis Desrochers.

"Maxi-Sol specializes in the production of table market potatoes," says Desrochers, who is also the vice president of La Federation de Pommes de Terre du Quebec, the potato growers' association in that province. "We cultivate a total of 400 acres of potatoes annually, which is divided between a 30 per cent share for white potato, 10 per cent for red and 60 per cent for yellow flesh potatoes."

Almost 75 per cent of the harvested potato crop is stored on the farm, while the balance is sold directly off the field during harvest. In a semi-automated packaging centre, Maxi-Sol produces bags of five pounds, 10 pounds, 20 pounds and 50 pounds. Potatoes are sold to large food chains, fruit and vegetable stores and restaurants in Quebec, while some are exported to the United States.

"Due to the consistent quality of our products, our company differentiates and increases its market share annually," says Desrochers. "In 2014, Maxi-Sol will offer small sizes [of] paper and plastic bags for its different varieties. Potatoes that are packed in smaller size bags is a niche market in the consumer sector and still needs to be developed in Quebec."

Desrochers points out that the company is well known in Quebec for the production of yellow potatoes. He says Maxi-Sol was the first potato operation in Quebec that started growing the yellow variety Vivaldi and the company is now recognized as a leader in the production of this popular oblong variety.

To ensure a good harvest in the fields, especially on sandy fields, Maxi-Sol uses a linear irrigation system as well as a center pivot, both with variable water application rates to suit the needs of each field and variety.

"With these two irrigation systems, more than 230 acres receive 20 millimetres of water in only 36 hours," says Desrochers. "The irrigation systems operate at low pressure, less than 80 psi at the pumps compared to the 140 psi to operate reels, also known as self-traveling sprinkler systems. This translates into an energy saving of 60 per cent."

Maxi-Sol plans to replace the existing reel systems with linear and center pivot systems in the near future.

According to Desrochers, Maxi-Sol faces several challenges.

"In Quebec, standards for the use of phosphorus in inorganic or organic form are strictly controlled," he says. "Therefore, our company must provide an agro-environmental fertilization plan and phosphorus balance to the environmental department annually. This is time consuming and management intensive."

Another challenge is combatting scab, considered to be a serious problem in Quebec. In 2013, Maxi-Sol initiated a research project into this potato disease, planting 250 different seed varieties in micro-plots to study how these varieties behave in loam-sandy soils in terms of their resistance to scab.

Maxi-Sol, which maintains close ties with researchers at Agriculture and Agri-Food Canada's Potato Research Centre in Fredericton, N.B., improves its crop production by employing new cultural practices such as applying natural fungi or mycorrhiza at the roots of tubers in the field.

Desrochers notes that Maxi-Sol "is a company that stands out for its social involvement with the farming community and consumers, as well as its concern with sustainable farming practices." He adds his company operates on the principle of maintaining solid, sustainable growing practices as the only way to ensure a viable future in potato production for the next generation of potato growers. **Lukie Pieterse**

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