FUTURE OF FARMING

Unlocking the potential of Canada's agriculture and agri-food sector

AS A NET EXPORTER OF AGRI-FOOD PRODUCTS, CANADA HAS THE OPPORTUNITY TO SET ASPIRATIONAL GOALS AND ACHIEVE NEW LEVELS OF INNOVATION

Overcoming a range of regulatory and logistical obstacles remains a prerequisite to meeting the ambitious goal set by Canada's Agri-Food Economic Strategy Table last year, but progress is being made, says Evan Fraser, director of the Arrell Food Institute and a Canada Research Chair in Global Food Security at the University of Guelph, Ontario.

The targets – an increase in agri-food exports to $85-billion and domestic sales to $140-billion representing increases of 31 and 27 per cent respectively – are key to achieving the Strategy Table's vision of Canada being one of the top five global competitors in the agri-food sector by 2025, recognized as the most trusted, competitive and reliable supplier of safe, sustainable, high-quality agri-food products and an innovator in value-added products.

The vision includes Canada having a leading digital and technology-based supply chain and standing out as the world's favoured protein provider.

The report concludes that the global agri-food market in 2025 will be highly competitive and filled with new challenges. As one of the few net exporters of agri-food products, Canada has both an opportunity and a duty to set aspirational goals and achieve new levels of innovation.

> **While there's always more that can be done, the question is where has progress been made and where does progress need to be made.**
>
> **Evan Fraser**
> director of the Arrell Food Institute and a Canada Research Chair in Global Food Security at the University of Guelph

"Canada has the entrepreneurial legacy and grit to seize a significant share of the global agri-food market and grow domestic sales as well, achieving multi-billion-dollar targets by 2025," according to the report's authors. "What we need are the right conditions to make that happen – starting with urgently needed regulatory reforms and infrastructure upgrades, and supported by considered strategies for market diversification, technology adoption and the development of skills, talent and labour capacity to meet the sector's competitiveness."

Prof. Fraser says several recent developments indicate that Canada is on the right track to advance its agri-food sector, including the federal government's $153-million investment over four years in the Protein Industries Canada Supercluster.

Based in the Prairies, the Supercluster will use plant genomics and novel processing technology to increase the value of key Canadian crops, such as canola, wheat and pulses destined for high-growth foreign markets, such as China and India. Producers will also serve growing markets in North America and Europe for plant-based meat alternatives with the aim of establishing Canada as a leading source for plant proteins.

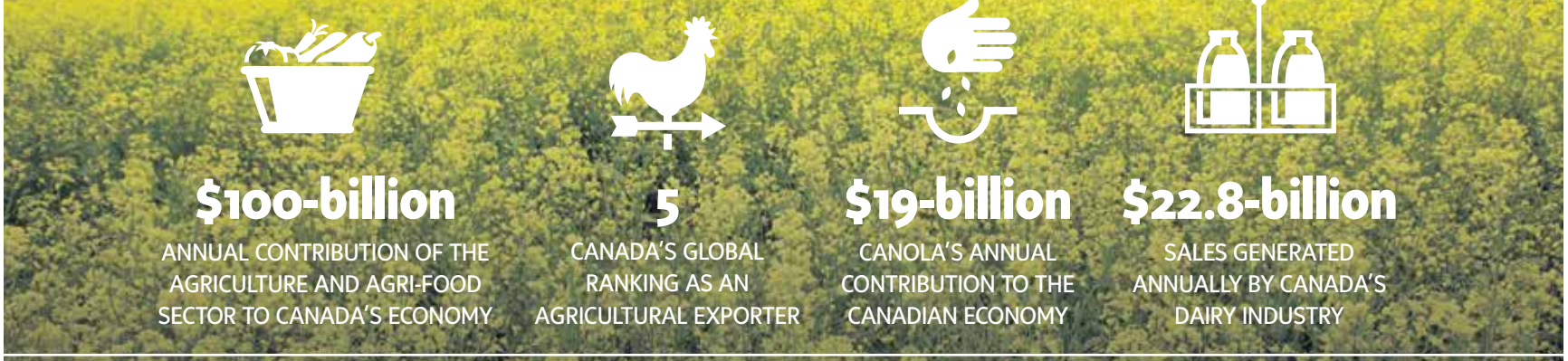
The government believes the supercluster will have an economic impact of $4.5-billion over 10 years and create 4,500 jobs.

"While there's always more that can be done, the question is where has progress been made and where does progress need to be made. I think we've had some very impressive federal investments in the agri-food sector in the past few years," says Prof. Fraser.

He also points to a Senate report released in July highlighting opportunities for Canada in the value-added agri-food sector.

To illustrate how Canada lags in adding value to its agri-food products, the Senate report noted that in 2016, exports of processed food and beverages were valued at $33.5-billion. By comparison, the Netherlands, which has about 34 times less farmland than Canada, exported $73.1-billion worth of value-added products in the same year.

See AGRI-FOOD, F7



SOURCE: AGRICULTURE AND AGRI-FOODS CANADA

WHAT'S INSIDE:

RESEARCH

MAPPING THE WHEAT GENOME WILL IMPROVE GLOBAL FOOD SECURITY

The mapping of the wheat genome by an international team co-led by researchers from the University of Saskatchewan (USask) provides a fundamental tool for wheat research and plant breeding to develop better varieties with that can combat diseases, tolerate temperature and rainfall extremes, and meet different consumer needs, all while improving global food security.

USask is renowned for its work in Northern Great Plains agriculture, an area that will be increasingly important for future food production.

"With climate change, we will lose a lot of agriculture capacity around the equator – it's just going to be too hot. That means that as agricultural productivity moves north, managing [the land base in] the Northern Great Plains will be critical for supplying food and other renewable resource-based items for the entire world," says Mary Buhr, dean in USask's College of Agriculture and Bioresources, pointing out wheat is the world's most widely grown crop. "That's why this mapping of the wheat genome is so important."

> **An achievement like this shows we have the brains, the leaders and the team-building ability to lead the future.**
>
> **Mary Buhr**
> dean in USask's College of Agriculture and Bioresources

For Curtis Pozniak, professor and wheat breeder at USask's Crop Development Centre, tackling the wheat genome began several years ago when his team, together with colleague Andrew Sharpe from the university's Global Institute for Food Security, joined the International Wheat Genome Sequencing Consortium with the objective to develop a high-quality reference sequence of the bread wheat genome.

At that time, the team was working on a sequencing approach that was becoming outdated and expensive, says Dr. Pozniak.

"But science is always marching forward, and we wanted to be on the leading edge of technology. Two major changes happened over that time: the sequencing technology improved and became a lot cheaper, plus the computational biology that we needed to take that raw sequence information and reassemble it into a complete genome sequence also evolved," he says.

After years of research, funding from a range of partners and working with the Israeli company NRGene, the actual sequencing and assembly took only three months.

The sequence, now in the public domain, is available to enable researchers, biologists and plant breeders around the world to further their work.

"All the researchers who were involved in the project recognized how important it is to advance research. It is a fundamental tool for biology and research in wheat," says Dr. Pozniak, noting the manuscript that describes the wheat genome sequence has been cited more than 700 times in peer-reviewed publications since it was published in late 2018.

He considers the genome sequences as a blueprint.

"Wheat breeding has been successful for well over 100 years, but now we have access to the sequence – the genetic blueprint of wheat. That blueprint serves as a roadmap of all the genes, which paves the way to decipher those parts of the genetic code that can help wheat yield more and combat changing diseases, extreme temperatures or even changes in consumer preference. In the future, we can tackle these issues with

See WHEAT GENOME, F6

ENHANCING AGRONOMIC DECISION-MAKING

As farmers strive to decrease their environmental footprint, new tools are emerging to help them increase production

The ingenuity it takes to grow food sustainably today might surprise the average consumer.

"The key right now is data and how to use it," says Al Driver, country division head for Bayer Crop Science in Canada. "Instant, reliable crop information that improves agronomic decision-making helps farmers adapt to climate change, diversify crops and increase production – all while decreasing the environmental footprint."

However, while farmers must manage challenging new weather patterns and control diseases and pests, they also need to be mindful of global market access and regulations in countries that import crops grown in Canada.

"The world is becoming smaller but a lot more complex," says Mr. Driver, noting the challenges of growing a crop are only part of farmers' responsibilities in the food supply chain.

"At one time, regulatory clearance in Canada was enough to export grain anywhere in the world. Now agriculture is a global industry that requires significant expertise and understanding of regulations related to crop protection, seeds and traits," he says.

A short growing season [100-170 days] means the industry needs new seed technologies that can reach maturity in the Canadian environment, adds Mr. Driver.

"At Bayer, we are developing corn and soy varieties for farmers to rotate in with their current crops, giving them the flexibility to diversify their products," he says. "This decreases the risks in fluctuating commodity prices and keeps their farms viable."

Cherilyn Jolly-Nagel, who farms canola, chickpeas, lentils, wheat and barley with her husband David Nagel on 18,000 acres in Mossbank, Saskatchewan, agrees profitability is a challenge, and says farmers are dependent on world markets and susceptible to trade disputes.

"We wouldn't still be here if we didn't have some adaptations in seed genetics. We have seen massive improvements in canola that allow us to make improvements in the way we harvest – in terms of time, efficiency and overall production, it is a game-changer for canola," she says.

Ms. Jolly-Nagel points out that farmers are always open to innovative technology and new ways of doing things.

"Historically, if there wasn't a solution available, we innovated and adapted and made our own solution. But in a time of austerity budgeting, where we are now with low prices and rising costs of equipment, technology and data collection, if the innovation is not affordable, it's not accessible. It must pay for itself," she says.

Top: A farmer examines her crop and gathers data; above left: A quadrocopter is used to gain an aerial view of a field of canola. Above right: A farmer inside the cab of a tractor/combine uses FieldView, a software program that simplifies data management. BAYER CANADA

Mr. Driver says technology such as Climate FieldView, a farm software platform that simplifies field data management and supports better decision-making, offers farmers advantages by incorporating data from other sources, satellite images and managing seed records, fertilizer and crop protection applications, and crop yield.

In addition to planning for the next crop year, these records are increasingly necessary as other partners in the supply chain, such as food processors, require crop tracking information, he adds.

Denise Hockaday, climate business lead in Canada for Bayer subsidiary Climate Corporation, says the benefit of FieldView is that it is automated to seamlessly manage information, which translates into faster and better experiences for farmers who need to make decisions quickly.

"When harvesting crops, farmers need to think about positioning their equipment [and] the people they need to deploy to get the crop harvested when quality is at its highest. Using FieldView, they have all the information they need at their fingertips to make these decisions," she says.

"As an example, farmers can't walk an entire field, but FieldView's imagery services enable the farmer to see the field – often many thousands of acres – and alert him or her to any issues that need attention," says Hockaday. "The platform's shareability is also an advantage. Farming is a team sport, and farmers often rely on experts such as agronomists for advice – with FieldView, the agronomist can access the information."

Looking ahead, Ms. Jolly-Nagel sees communicating with the public as one of the biggest challenges facing the industry.

"Taking advantage of science and innovation is a privilege, and to protect that privilege we need to share the science and share the reasons we need it," she says.

There is a growing trend for more traceability and transparency in the food production system. Ultimately, farmers, as the front-line producers of food, are accountable to consumers. Their success is determined by consumer habit. If the agricultural industry is to continue supporting Canadians and the economy, while staying ahead of climate change and other pressures, it will need continue building bridges between those who grow the food and those who consume it.

AGTECH

TIME TO RAMP UP THE FARMING REVOLUTION

Smart machines are rapidly taking over agri-food tasks previously done by humans, increasing the need for workers with data science skills right across the sector's value chain, according to a new report by RBC.

The Farmer 4.0 report describes the shift as farming's fourth technology revolution after the domestication of plants and animals, the mechanization of work, and the mass scaling of genetic and chemical science, all of which led to profound changes. The fourth revolution will be no less powerful, say the report's authors, if investments are made in the skills that will shape Farmer 4.0.

"Farmer 4.0 will be working in office towers, data centres and engineering labs around the country, plugging into the people and machines that can turn our land and water into a hyper-efficient and sustainable food source for the planet," the report states.

But it says more needs to be done to prepare the Canadian agri-food sector for the challenges of growing competition in a data-driven world and warns that Canada is lagging in the agtech race.

While global investment in agtech reached record US$16.9-billion last year, up 43 per cent from 2017, Canada's share of global agtech investment was 3.4 per cent, which is less than that of either India or Brazil, emerging economies that have significantly boosted their market share in agricultural exports in the last two decades.

Evan Fraser, director of the Arrell Food Institute and a Canada Research Chair in Global Food Security at the University of Guelph, Ontario, says the report shows how "unbelievably fast" the agri-food market and labour sector are changing.

"Rapid innovations in technology are leading to lower-skilled mechanical jobs being taken over by robots, but an increase in other job opportunities such as data management, software design and robotics at the back end and marketing, PR [public relations], delivery, logistics and retail at the front end of the food chain," he says.

> **"We need to establish coherence in common data collection protocols, cybersecurity protocols as well as enhancing rural broadband so that the data can come off the farms in a fast and efficient way.**
>
> **Evan Fraser**
> director of the Arrell Food Institute and a Canada Research Chair in Global Food Security

This means agri-food studies are now broadening to include not only traditional subjects like animal husbandry, crop science and soil science, but data science as well, adds Prof. Fraser.

"Data is the weakest link in our value chain, and it's not just in agri-food, it's the economy writ large. This is a big problem," he says.

For example, Prof. Fraser says the question of data governance and data integration is crucial. At an operational level, the question of how to aggregate data, enhance cybersecurity and preserve anonymity becomes enormous.

"Interoperability of data is needed to track food from farm to fork," he says. "This means we need large-scale data governance systems that will drive transparency and accountability and also drive efficiency. We need to establish coherence in common data collection protocols, cybersecurity protocols as well as enhancing rural broadband so that the data can come off the farms in a fast and efficient way."

The RBC report says Canada could gain $11-billion in annual GDP by 2030 by closing the agriculture labour gap and accelerating investment in technology. This would bring agricultural GDP to $51-billion, making it bigger than automobile assembly and aeronautics combined.

And while few countries are better positioned than Canada to help feed a growing global population, Canada could also fall behind as the rest of the world moves rapidly into a new age of food production.

The report notes that Canada's share of global exports fell from 6.3 per cent in 2000 to 4.9 per cent in 2005 to 3.9 per cent today. While that's due in part to more farmers in more countries growing more food for the world, it's also due to Canada's agriculture productivity having stalled.

Canada needs to accelerate the adoption of innovative technologies, according to the RBC report Farmer 4.0. ISTOCK.COM

New trade agreements should help the agri-food sector regain some market share, but to seize on those opportunities, Canada needs to transform the way we produce food, and market it globally. If that doesn't happen, the sector will likely grow by only 1.8 per cent annually on its current path of declining productivity, says the report.

"But if we accelerate the adoption of innovative technologies and embrace an ambitious skills agenda, our research indicates Canada's agricultural productivity can get back in line with the recent 10-year average of 3 per cent. The payoff: another $11-billion of output, bringing agricultural GDP to $51 billion in 2030," according to the report.

And Canada can add even more if it follows the lead of the Netherlands or Australia to develop world-class skills and embraces a culture of innovation across the sector.

The report notes that six Canadian universities rank in the top 100 agriculture and forestry programs globally, according to the widely respected QS World University Rankings, and points out that the number of students in agricultural programs has jumped 29 per cent in the past decade – a faster pace than the 21 per cent growth across all programs.

"But in the decade ahead, we will need a lot more of that – as well as a better approach to lifelong learning for those already at work, and a continuous approach to new skills. It's not just digital skills," the report states. "Across the country, we heard about the need for agriculture managers with experience in human resources and integrated systems management, and more exposure to programs focused on finance, engineering and environmental studies."

PASSING ON THE FAMILY FARM

Census shows only 8 per cent of farms have a formal succession plan

Family farms are the backbone of Canada's agricultural sector, comprising 92 per cent of all farms, but the transition from one generation to the next is often the toughest of the many challenges farming families face, says Liz Robertson, executive director of the Canadian Association of Farm Advisors (CAFA).

Statistics Canada's 2016 Census of Agriculture found that the average age of farmers had increased to 55, but only one in 12 (8 per cent) farms reported having a formal succession plan laying out how the operation will be transferred to the next generation of farmers.

Passing on the family farm is not what it used to be: not too long ago, children would leave school to work on the farm and then take over when their father retired. Family farms are much bigger and more complex businesses than they were 100 years ago; new technology and sophisticated equipment mean labour needs have decreased, but costs have gone up.

Farmers benefit from post-secondary education and off-farm work experience before they take over the family farm. Knowing their strengths, being able to delegate and making tough decisions, sometimes not always popular, are business management skills they need to develop.

> **There are many elements in a transition – management, tax, technical knowledge – but when I talk to our (CAFA) members, they all say it comes back to those two things; good communication and leadership.**
>
> **Liz Robertson**
> executive director of the Canadian Association of Farm Advisors

The value of farmland has increased significantly, so raising the money to buy out the family farm is a challenge. ISTOCK.COM

Ms. Robertson says successful transitions depend mainly on good communication within the family and strong leadership.

"There are many elements in a transition – management, tax, technical knowledge – but when I talk to our (CAFA) members, they all say it comes back to those two things: good communication and leadership. Those seem to be the secret to getting the transition process started and maintained," she says.

That doesn't necessarily mean the transition will be problem-free. The value of farmland has increased significantly in most regions over the last generation, so sons and daughters need to find the money to buy out their parents, and many parents want to ensure that their children who have moved to the city and don't want to farm get at least something fair from the farm transition, says Ms. Robertson.

She points out that farms are expensive, and for families in transition, ensuring the next generation has enough capital to buy the farm while leaving the previous generation with enough to retire can be challenging.

"It's these types of issues that transition planning needs to address, and often the best way to do so is with the help of an outside adviser who has no vested interest, but does have knowledge and experience and access to a range of other experts – accountants, lawyers and tax planners – to help the family move forward," adds Ms. Robertson.

CANADIAN EGG FARMERS PROVIDE FOOD FOR OUR FUTURE

Research shows the egg industry's increase in production comes with a decrease in its environmental footprint

As Canada's egg industry continues to lower its environmental footprint, research and innovation are increasingly positioning eggs as a climate-smart food that will play an important role in helping to feed the world's growing population.

Egg Farmers of Canada (EFC) CEO Tim Lambert says consumers' shift toward higher-quality nutritional choices with fewer processed foods and more fruit and vegetables in their diets has contributed to the growth in egg consumption in the last decade – Canadians now eat more than 250 eggs per person a year.

EFC's role as a key player in food systems is being strengthened as egg farmers become increasingly focused on the industry's impact on the environment and climate change. Consumers want to know more about where their food comes from and be confident that the industries producing food understand the importance of the environment and sustainability, says Mr. Lambert.

"Sustainability is central to our vision of how to grow our industry," he adds.

As the most efficient form of animal protein in terms of impact on the environment, according to the Protein Scorecard developed by the World Resources Institute, eggs have a natural advantage, says Mr. Lambert, adding that the industry has already significantly reduced greenhouse gas emissions by 72 per cent.

To maximize this natural advantage, EFC supports research chairs at four Canadian universities including Nathan Pelletier at the University of British Columbia, who is exploring ways to reduce the environmental impact of egg supply chains.

Dr. Pelletier, an ecological economist who also holds the prestigious Natural Sciences and Engineering Research Council of Canada (NSERC) Industrial Research Chair, led an environmental and social analysis to compare the egg industry's environmental footprint in 1962 vs. 2012. This research had striking findings: over the 50-year span, there was a 50 per cent increase in egg production with a 50 per cent reduction in resources and a 50 per cent smaller environmental footprint.

Dr. Pelletier's five-year NSERC-funded research, which includes projects by 10 masters and two PhD students, is focused on how that trajectory can be maintained.

This spring, he expects to rollout a lite version of the National Environmental Sustainability Tool (NEST) that will include benchmarking and indicators to provide information on how farmers across the country are currently performing in terms of resource efficiency indicators. The full version of NEST will provide the tools farmers need to measure their own farm's environmental performance, compare that performance year over year, set goals and track progress, and compare performance benchmarks specific to their region.

> **As the most efficient form of animal protein in terms of impact on the environment, according to the Protein Scorecard developed by the World Resources Institute, eggs have a natural advantage.**
>
> **Tim Lambert**
> Egg Farmers of Canada (EFC) CEO

In 2018, the Canadian egg industry marked a dozen years of consecutive growth. Tim Lambert, CEO of Egg Farmers of Canada, says sustainability is central to the organization's vision of how to continue to grow the industry. SUPPLIED

While EFC supports programs to combat hunger in Canada, including breakfast programs at several schools, the industry is also aligned with global initiatives that will ultimately help feed the world's growing population.

The International Egg Commission (IEC), whose board Mr. Lambert chairs, supports the United Nations' 17 Sustainable Development Goals (SDGs), launched in 2015 to tackle the world's economic, social and environmental issues.

"We brought that thinking into Egg Farmers of Canada, that we need to be champions of climate change," he says.

EFC's outlook reflects many of the SDGs objectives such as sustainable communities and climate action. Partnerships for sustainable development is also an area where the organization is actively involved, including collaborations with Canadian universities, its meetings with NGOs and its lead role in a sustainable egg farm in eSwatini (formerly known as Swaziland) to provide a protein source for a local orphanage and community.

Looking ahead, Mr. Lambert says the next frontier will be the application of precision agriculture technologies to the sector.

"Net-zero barns, recycling poultry manure into energy, repurposing inputs and finding ways to reuse them – a circular economy concept – is a big opportunity," he says. "I think you'll see advancements continuing in micronutrients and feed that help us minimize what goes back into the environment and improving the efficiency of the use of feed."

He also believes Dr Pelletier's work to develop benchmarks for the industry will have a major impact, enabling farmers to make better decisions.

EGGS BY THE NUMBERS

In addition to providing high-quality protein while reducing its environmental footprint, the Canadian egg industry is a major contributor to the country's economy.

752 million dozen
The number of eggs produced by Canadian egg farmers in 2018.

253
The average number of eggs consumed per capita by Canadians in 2018 – an increase of 4.5 per cent over 2017.

50 per cent
The environmental footprint of Canada's egg production supply chain declined by almost 50 per cent between 1962 and 2012, while egg production increased by 50 per cent.

17,600
The number of people the egg industry employs across Canada.

$1.37-billion
The egg industry's contribution to the Canadian economy. It also contributes nearly half a billion dollars in revenue to federal and provincial governments every year.

Source: Egg Farmers of Canada

POLICY

ROADMAP TO A HEALTHIER AND MORE SUSTAINABLE FOOD SYSTEM

Improving Canada's food system and providing reliable access for all Canadians to enough healthy food and reducing food waste are key objectives of the country's first-ever food policy recently announced by the federal government.

According to the government, the policy is based on input from more than 45,000 Canadians, including food producers and processors, experts in environment, health and food security, Indigenous groups, non-government organizations and community advocates.

To support the policy, the government is creating a Canadian Food Policy Advisory Council and launching a five-year, $50-million Local Food Infrastructure Fund, designed to support community-led projects that improve access to safe, healthy and culturally diverse food.

In announcing the new policy, Marie-Claude Bibeau, Minister of Agriculture and Agri-Food, said it is a roadmap for a healthier and more sustainable food system for Canada.

"The investments and initiatives in the food policy will contribute to economic growth, better nutrition and food security for all Canadians," she said.

Gisèle Yasmeen, executive director of Food Secure Canada (FSC), a pan-Canadian alliance of organizations and individuals working together to advance food security and food sovereignty through three interlocking goals: zero hunger, healthy and safe food, and sustainable food systems, says FSC has been calling for government leaders to develop a joined-up national food policy since its founding in 2001.

"Canada needs a more healthy, just and sustainable food system that ensures everyone's right to food. The very establishment of a federal food policy, with associated budget lines, is an important first step in realizing that vision," she says.

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>
> **Gisèle Yasmeen**
> executive director of Food Secure Canada (FSC)

The Canadian government's Local Food Infrastructure Fund will support community-led projects to improve access to safe, healthy and culturally diverse food. ISTOCK.COM

She points out that apart from the multi-stakeholder Canadian Food Policy Council, the policy includes provision for the development of a National School Food Program, financial support for local food infrastructure, communities tackling Northern food insecurity, food waste reduction programs, and a pilot project towards permanent residency for immigrant farm workers.

However, Ms. Yasmeen says while the policy and its associated budget are a start, they do not yet have the scale required to bring four million Canadians out of food insecurity. They also don't address the role of the current industrial food system in diet-related disease and the climate crisis, or recognize or work to strengthen food sovereignty, particularly with respect to Indigenous Peoples.

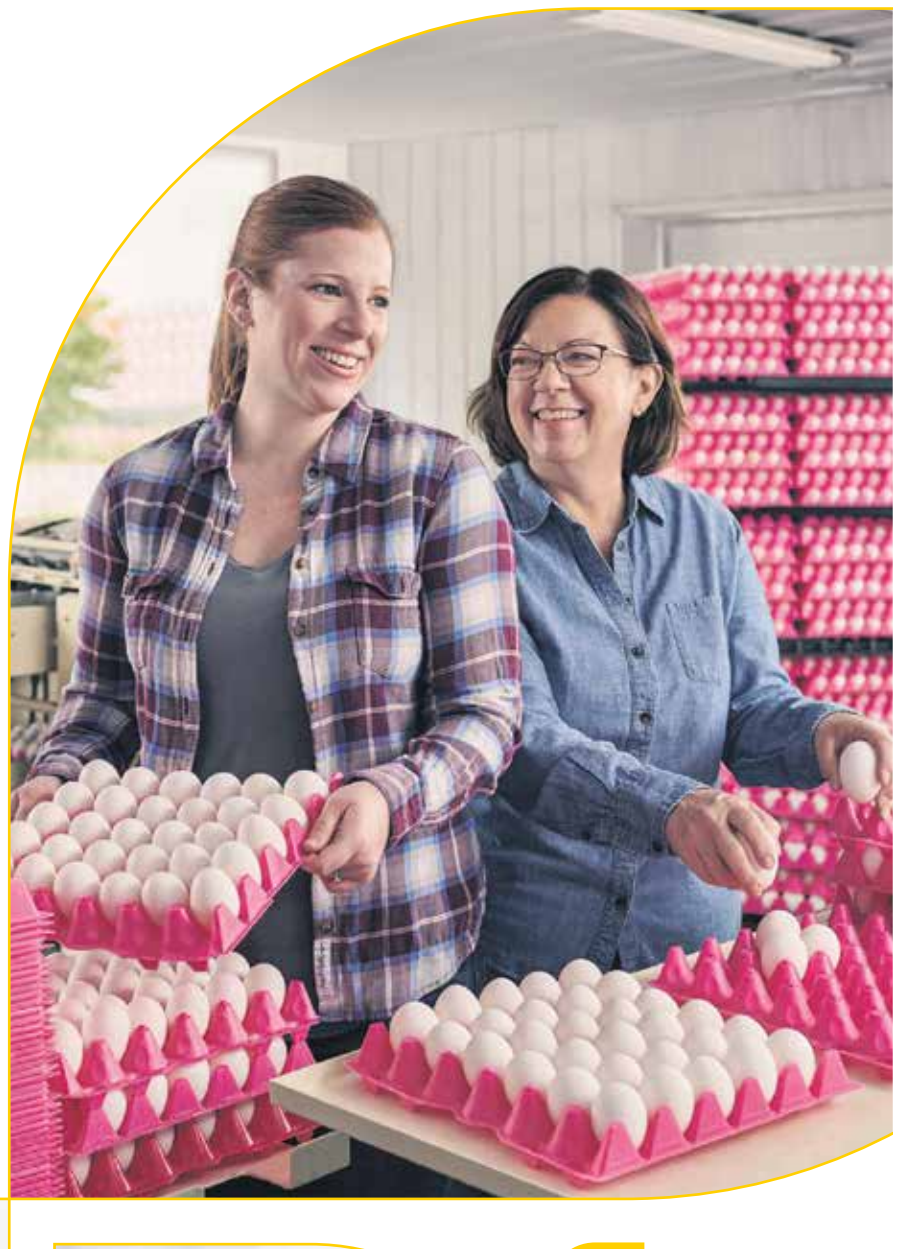
"The policy says it will support 'strong and prosperous First Nations, Inuit and Métis food systems,' which should be defined by the communities themselves. But it does not address Indigenous land rights, which is essential for supporting the policy's objective of Indigenous 'food self-determination' which, for it to be genuine, must include the ability to control decision-making around all aspects of food production and consumption," she says.

Labour issues in the food system and issues related to climate resilience, public trust, health and sustainability, such as the labelling of genetically modified foods and the regulation of toxic pesticide use, are also absent or largely overlooked in the policy, says Ms. Yasmeen.

"The policy has the vision and scope to make a real difference," she adds. "But the initial financing of $134.4-million is incommensurate with the scale of the challenge that the policy itself lays out. It will be difficult to promote the move toward a healthier, more just and sustainable food system without significant additional investments."

Ms. Yasmeen believes success will depend on how the policy is funded, implemented and governed over time.

"If it is pursued energetically, with the broad participation of diverse groups and with funding to match the stated vision, this first food policy for Canada could be groundbreaking," she says.



Canada's egg farmers are leading the way to a *sustainable future*

With innovation and new efficiencies, we're helping pave the path to a sustainable future for the fresh, high-quality eggs that Canadians love.

EGG FARMERS OF CANADA

Read *our Sustainability Story* at **eggfarmers.ca** to learn more.

COLLABORATION ACCELERATES INNOVATION

Helping farmers deal with changing weather patterns and mitigating the sector's impact on climate change

As a major participant in Canadian agriculture, Syngenta Canada's president Trevor Heck knows that collaboration is fundamental to accelerating innovation.

"We have a mantra: Helping farmers grow the best crop. It's important for us, whether it's supporting the grower directly or their retailer or crop consultant, to make sure that they're aware of the best solutions for that farm operation – and know that we can bring in, or partner with, others to provide the best solution," he says.

As a leader in crop protection and seed innovation, Mr. Heck says the current activity in the agriculture sector reminds him of the dotcom era.

"So many companies and organizations are looking to do things differently. If you want to bring the best solutions to growers, you're going to have to collaborate to access the best products, services and technologies," he says.

But with climate change and its implications for biotic (living things in the ecosystem such as weeds, insects and fungal diseases) and abiotic (non-living things in the ecosystem such drought or cold) stresses, there is a real sense of urgency, says Nancy Tout, Syngenta Canada's head of research and development.

One of the solutions lies in the development of plants that are more resistant to the impacts of climate change, says Dr. Tout. "And, on the other side of the equation, we are also working to mitigate greenhouse gas emissions from agriculture through agronomic practices, improved soil health and feed for livestock, by way of a few examples."

While crop protection and seeds remain the priority, many of the advances in these areas are based on significant investments in and the ability to harness the power of technologies in adjacent spaces such as precision agriculture, data analytics and predictive technologies.

"Precision farming is part of the future of agriculture in Canada. A lot of data is being collected – how it is used to help farmers make the multitude of decisions they are faced with is going to change the face of farming," says Dr. Tout.

Some of these technologies are already being deployed to support Canadian agriculture, says Mr. Heck, citing the ability of farmers to view fields using satellite imagery or drone-based technology as a good example. With some fields covering many hectares of land, this technology can be used to alert farmers to issues that are not visible from the periphery of the field, such as a pest infestation, for example, that risks going undetected and unaddressed and causing significant harm.

"Once seen, it can be targeted and managed using precision farming methods," he says.

Strategies to improve productivity and produce food for current and future generations can also have a positive impact on other aspects of sustainability.

Increasing production on the existing agricultural land base or 'sustainable intensification' helps to protect and enhance biodiversity. We can have more habitat for wildlife, forests, wetlands and grasslands that are left untouched by agricultural production, says Mr. Heck.

"A big part of our focus when we talk about accelerating innovation is looking at how we can make sure that what we're doing is being done on the right land-base, but at the same time protecting that base by minimizing the resources required for production purposes," he says. "It's about being as effective as we can possibly be with both the natural and synthetic inputs that we need. It's going to take all of our creativity, innovation and collaboration, and we're committed to playing an important part in getting us there."

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>
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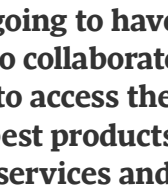


Addressing the impacts of climate change is top of mind for both farmers and the general public. SYNGENTA CANADA

FROM PAGE 1

WHEAT GENOME: UNDERSTANDING ITS IMPACT ON AGRONOMIC PERFORMANCE

more precision than we've been able to do in the past," he says.

While working on the wheat genome project was a career highlight, Dr. Pozniak continues his work to understand each piece of the genome and its impact on agronomic performance and disease resistance.

He is also leading the 10+ Wheat Genomes Project, another international initiative that is sequencing a number of different wheat varieties from around the world.

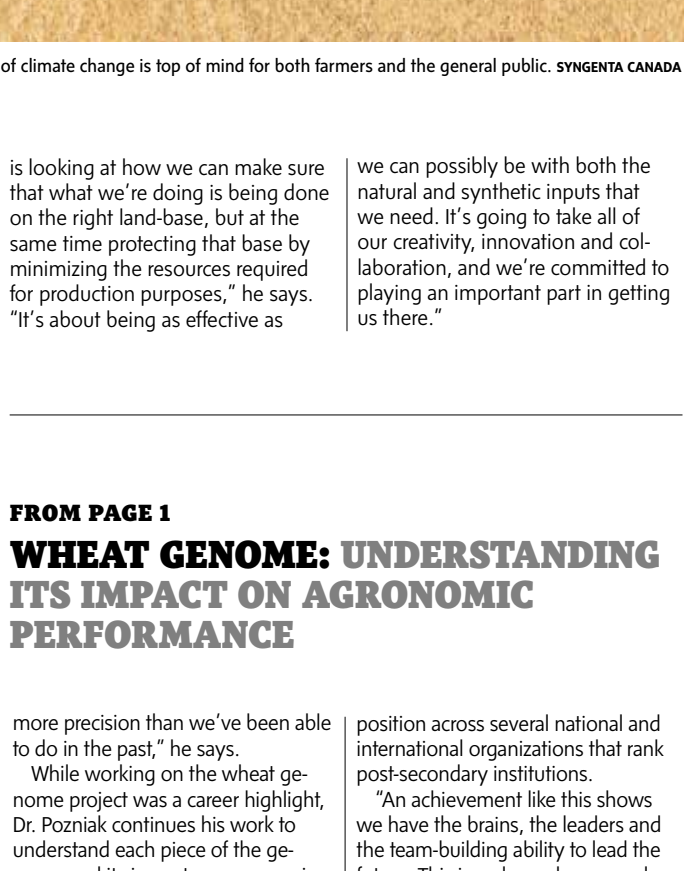
"One genome is simply not enough. We need multiple sequences to compare, so that we can really appreciate the differences between wheat varieties and to fully appreciate the genetic diversity for wheat improvement."

USask's leading role in mapping the genome – a genome that is five times larger than the human genome – further underscores the university's highly ranked position across several national and international organizations that rank post-secondary institutions.

"An achievement like this shows we have the brains, the leaders and the team-building ability to lead the future. This is a place where people who are capable of achieving greatness are encouraged and able to do so," says Ms. Buhr.

That reputation attracts attention and makes the university a destination for researchers, graduate students, companies and for countries that are seeking solutions, she says.

Funding for the Canadian work was provided by Genome Canada and Genome Prairie; Saskatchewan Ministry of Agriculture and Government of Canada through the Agriculture Development Fund; Western Grains Research Foundation; Saskatchewan Wheat Commission; Alberta Wheat Commission; and Manitoba Wheat and Barley Growers Association.



Curtis Pozniak, professor and wheat breeder at USask's Crop Development Centre, spent years as part of a team working on mapping the wheat genome that is now available to researchers, biologists and plant breeders around the world. SUPPLIED

GLOBAL LEADER IN SHORTLINE EQUIPMENT

Farm equipment manufacturers help feed Canada and the world

Canadian farmers know all about necessity being the mother of invention. In the early days, faced with unique and sometimes extreme farming conditions, farmers often found that the available agricultural equipment didn't meet all their needs. So they adapted and innovated and established an industry that now not only supplies Canadian farmers with much of the equipment they need, but also annually exports more that $2-billion of specialized agricultural equipment to 150 countries.

Canada is a global leader in shortline or niche equipment – tillage, planting and haying machines produced by manufacturers that focus on a specific type of farm equipment. Virtually all of Canada's more than 300 agricultural equipment manufacturers are shortline. Mainline manufacturers supply a full line of products to farmers.

The industry has evolved as a distinct sector of innovation and economic activity relative to other manufacturing sectors. Some of the world's most innovative agricultural equipment has been and continues to be developed and made in Canada – and the pace is accelerating as more farmers embrace new technology to make their operations more efficient and sustainable.

Big data, the Internet of Things, robotics, driverless harvesters and tractors, automated planters and monitoring devices to advise farmers on everything from when to irrigate to the optimum time for harvesting are transforming Canadian farms.

Agricultural Manufacturers of Canada (AMC) a national, member-driven industry association representing more than 250 agricultural equipment manufacturers and associated suppliers, notes that equipment manufacturing is a growing industry in Canada, with revenues averaging just over $3-billion per year.

As more farmers adopt new technology to help run their operations, their relationship with manufacturers is also evolving.

Cor Lodder, an AMC director and corporate director of equipment manufacturer Walinga Inc., and operations manager of the company's machining division in Carman, Manitoba, says one of the results of the evolution of technology in agriculture is size reduction in equipment. While heavy equipment like tractors and harvesters remain large – albeit driverless and automated in many cases – other high-tech equipment, such as drones and machines to monitor pests and soil conditions, have become smaller and more precise.

"For example, instead of spraying a whole field using a large piece of equipment to deal with a pest, a micro-size unit can now pinpoint the exact location that needs to be treated and treat just that location," he says. "That reduces emissions from a large diesel vehicle, which helps lower the farm's carbon footprint and cuts down on damage to the land itself that can be caused by heavy equipment."

Canada is a global leader in shortline equipment such as tillage, planting and haying machines. ISTOCK.COM

In his own company, Mr. Lodder says automation is built into products such as pneumatic conveying systems and bulk feed transportation equipment that use air to move grain and other dry granular products, and are continuously monitored so that air speeds are automatically adjusted to maintain optimal performance and reduce energy costs.

Canadian-made agricultural equipment has an enviable reputation globally for quality and reliability and continues to be sought after in export markets, says Mr. Lodder.

FROM PAGE 1

AGRI-FOOD: ADDRESSING CRITICAL LABOUR SHORTAGES

Prof. Fraser says the government has also moved to address some of the labour challenges facing the agri-food sector including the recent launch of the Agri-food Immigration Pilot Program to address critical labour shortages in specific sectors including meat processing and mushroom production.

According to Ahmed Hussen, Minister of Immigration, Refugees and Citizenship, the three-year pilot program is expected to attract 2,750 principal applicants – plus their families – annually for a total of over 16,000 people.

Erasmus Okine, a specialist in a range of issues specific to Canadian agriculture and vice-president (research) at the University of Lethbridge in Alberta, agrees that progress is being made to achieve Canada's agri-food goals.

For example, he says the government's $153-million investment in the Protein Industries Canada Supercluster is a step in the right direction.

However, he believes efforts to reach the goals would be bolstered by additional investment and a more co-ordinated approach to research-enabling infrastructure.

"The investment in the Supercluster is the beginning, but its focus seems to be to commercialize research results. It is equally important to create research results with sustained and meaningful resourcing of research," he says.

For example, Dr. Okine says there seems to be the point of view that results should be immediate.

"That puts the research institutions in a corner," he adds. "We should always be thinking about the short-, medium- and long-term impacts of what we do. We – funders, researchers and society – benefit from a balanced approach to research investments."

NEW TECHNOLOGIES SET TO BOOST FOOD PRODUCTION

As a food exporter to over 150 countries, Canada has a major role to play in global food security

Seed development has resulted in canola crops requiring fewer resources such as water, fertilizer and pesticides. BASF

Changing weather patterns, pests and diseases are all putting pressure on the world's food supply. And with the global population expected to increase to 9.7 billion by 2050, the agricultural sector needs pioneering new technologies to meet the demand.

While better seed varieties developed through plant biotechnology and chemistry options will help farmers increase harvests, production plans to maximize yields from the acreage under cultivation will also require innovative digital technologies, says Jon Sweat, VP business management, Agricultural Solutions, BASF Canada.

"Over the years, growers have collected a lot of data ranging from local climate statistics to measuring inputs and outputs per acre in terms of yield and quality, but applying that data to enable them to make better production decisions and ultimately produce more with less is the challenge," he says. "There's not a lot of insight in terms of how to manage that data – lots of people touch pieces of it, but it's hard for them [the farmers] to put it all together."

> **"It's very important to [farmers] to make good decisions in the short term that also have good consequences in the long term.**
>
> **Jon Sweat**
> VP business management, Agricultural Solutions, BASF Canada

The answer is digital farming solutions, says Mr. Sweat.

"Ultimately it's about sustainability. Farmers want to take care of their land; that's their livelihood. It's very important to them to make good decisions in the short term that also have good consequences in the long term."

BASF's investment in digital farming technology, such as its xarvio Digital Farming Solutions, indicates the importance the Fortune 500 company places on the agriculture sector and its commitment to support growers with the tools they need to run sustainable farming operations.

"While the agriculture [division] represents roughly 10 per cent of BASF's sales, we receive 40 per cent of the research dollars," says Mr. Sweat.

Xarvio solutions use farmer-generated data and artificial intelligence in its scouting app that identify pests with a picture, and also alerts growers when diseases or pests have been spotted in an area so farmers can proactively take action to prevent crop damage. The xarvio Field Manager solution uses state-of-the-art crop modelling and satellite imagery to predict the best time to spray crops to prevent disease in the right areas of the field.

While digitization forges ahead, the company continues its focus on seed development, says Mr. Sweat. BASF's InVigor brand seed helps farmers grow higher-yielding, higher-quality canola using fewer resources such as water, fertilizer and pesticides.

One of Canada's other major crops – wheat – will benefit from a $500-million commitment by BASF to support the global research and development of hybrid wheat.

"We have a research station in Saskatoon that is preparing us for the Canadian market. A new hybrid wheat, expected by the middle of the next decade, will allow growers to grow a higher-yield crop using fewer resources than were traditionally necessary," he says.

Chemistry also remains a priority category.

"It's an important element of the grower's operation, because without it, up to 40 per cent of the crop would be lost to pests," says Mr. Sweat.

While crop protection products and new seed varieties are increasingly part of a farmer's toolkit, these innovations must be thoroughly assessed and approved before they can be used.

"There's a lot of science and a rigorous regulatory system that goes on behind the scenes for many years before those products end up in the hands of growers," says Pierre Petelle, president and CEO of CropLife Canada, an organization that champions agricultural innovations in crop protection and plant breeding.

"As we see the climate change, we're seeing pest pressures in Canada that we typically didn't have before – pests that are moving up into our zone. Farmers need those new tools that can help them control these new emerging pests," he says.

However, the system is not always nimble enough to keep up with the pace of innovation, says Mr. Petelle.

"Part of our role is to make sure that the regulatory system is not an impediment to innovation. We work very closely with the Government of Canada on those initiatives, and we're confident that Canada will continue to have the regulatory system that will encourage those innovations and make sure that Canadian farmers aren't left behind."

Mr. Petelle says many people are not aware of the challenges faced by farmers.

"Many people may not understand why farmers need access to tools like crop protection products or genetically modified crops; the reality is that even with the use of those tools, globally we're still losing 30 to 40 per cent of the food we produce."

To address the issue of food security, Mr. Petelle says Canada has a tremendous resource of land and natural resources and has a role to play in providing food for the rest of the world.

"More than 150 countries benefit from Canada's food production, so that's something to be proud of as Canadians," he says.

SUSTAINABILITY

SOCIAL VALUES MOTIVATE A NEW GENERATION OF FARMERS

For many young Canadian farmers, working the land is more than just a job; it's a viable and attractive lifestyle choice, says Clare Cullen, operations director, Centre for Sustainable Food Systems (CSFS) at the University of British Columbia's UBC Farm.

"We see many young people come to the UBC Farm wanting to learn about how to grow food, how to grow community and develop self-reliance while building strong connections to other like-minded people," she says.

"Many of these students have no farming background – they are completely new to the area and so perhaps come at it with a fresh approach that is more rooted in seeking a meaningful lifestyle and, even more, to have a positive impact on the world."

Ms. Cullen says farming today has become a "political act." It reflects values and beliefs and is a way to make actions count and voices be heard.

"For young people, living one's values is a high priority. Farming allows you to 'walk the talk,' show clearly what your approach is to the world, and have a visceral connection to your core values every day," she says.

This has become even more important as climate change makes all farming less certain and predictable, adds Ms. Cullen.

"Agriculture is one of the largest contributors to greenhouse gases so, in the very near future, we need to farm differently," she says.

Helping aspirant farmers realize their ambitions is a key element of CSFS's mission as a teaching and research centre and local-to-global food hub working towards a more sustainable, food-secure future. However, turning dreams into reality for young farmers can be challenging, says Ms. Cullen.

"Land access is a huge challenge, particularly in areas such as the (British Columbia) Lower Mainland where land prices are so high," she adds.

A closer relationship is developing between farmers and consumers, says Rodney Reid, vice-chair of the Canadian Young Farmers' Forum (CYFF). UBC FARM

> **"For young people, living one's values is a high priority. Farming allows you to 'walk the talk.'**
>
> **Clare Cullen**
> operations director, Centre for Sustainable Food Systems

Rodney Reid, vice-chair of the Canadian Young Farmers' Forum (CYFF), agrees that access to land is a challenge for young farmers, as is access to capital and labour, but there are also good opportunities in a growing agricultural sector.

"It's an exciting time to be a farmer," he says. "The industry is evolving rapidly through advances in technology and equipment, and a closer relationship is developing between farmers and consumers, who are increasingly interested in where their food comes from."

This view is echoed by Ms. Cullen, who says the growing consumer demand for organic produce – which is higher than Canadian farmers can keep up with – means there is room in the marketplace for more farmers to adopt organic practices.

"We are also seeing a move towards more plant-based diets, which will have the effect of reducing meat production over time in Canada," she adds. "As we know, raising livestock – particularly using conventional methods – is resource-intensive, so a reduction will benefit the climate."

CYFF general manager Guenette Bautz says young Canadians considering a career in farming need to invest in their education and business planning.

"Make this a priority and have a realistic awareness of the business; it's rewarding, but challenging," she adds.

Ms. Cullen encourages young people thinking about farming as a career to "go for it," but points out that education and training are challenges because many young farmers don't have a farming background. However, training programs such as those at UBC Farm and Kwantlen Polytechnic in British Columbia are helping to fill the knowledge gap, as are incubator farms where emergent farmers can experiment and test their skills over several years with all the equipment provided.

The federal government underscored its commitment to the success of young farmers last month with the announcement of an investment under the Canadian Agricultural Partnership's AgriCompetiveness Program totalling more than $700,000 for two projects to support the development of leaders among Canada's young farmers.

The CYFF will receive just over $616,000 to provide young farmers with business skills and learning, and networking and peer support opportunities to increase the profitability and efficiency of their operations.

Canada's Outstanding Young Farmers Program will receive $100,925 towards its three-day national recognition event, held annually to recognize young farmers who exemplify excellence in their profession and promote the value of agriculture to Canada and the economy.

Announcing the investment Marie-Claude Bibeau, Minister of Agriculture and Agri-Food, said the future of agriculture is in the hands of the new generation and that's why the government is committed to supporting young farmers.

Ms. Bautz says the government's investment will help CYFF continue to support Canadian famers by offering networking opportunities and providing education on topics not found in a traditional classroom.

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