How has innovation shaped the food system?

crop innovations

Wheat, oats, barley, maize and flax have been important grain crops in Canada for over a hundred years. Their importance over the years has varied, but these grains have all remained main crops. Canola and soybeans have also been leading oilseeds. Their history has influenced – and been influenced by – innovation in agriculture and their place in Canada's food system.

Canada is the world's largest exporter of hard red spring wheat and the three Canadian prairie provinces are the main wheat-producing provinces of Canada. Canada produces about 5 percent of the world's wheat, but exports over 75 percent of the wheat grown every year. Canada makes up about 20 percent of the world's wheat exports.

the wheat economy

Many of the farmers who came to Canada in search of free land and a better life had extensive agricultural knowledge and traditional practices. When these settler farmers got to Canada, however, they found that shorter growing seasons, different climate and soil conditions and the huge task of clearing the land created many challenges. Daily life could be quite difficult and crops were not always as productive as these farmers expected them to be.

With innovation and new inventions, wheat became such an important crop in the 1800s and 1900s that many historians have described conditions in Canada during that time as the "**wheat economy**."

Red Fife is a variety of wheat. It was introduced in Canada in 1842 and allowed farmers to increase their yield – the amount of wheat they harvested from a crop. These increased yields supported the expansion of farms and the railway as more wheat fed more people.

In 1911, the Canadian Pacific Railway offered a prize of one thousand dollars in gold for the best wheat variety in Canada! A new variety, called Marquis Wheat, won that prize.

Marquis Wheat was developed in 1907 – through much trial and error – at the Dominion Experimental Farm in Indian Head, Saskatchewan.

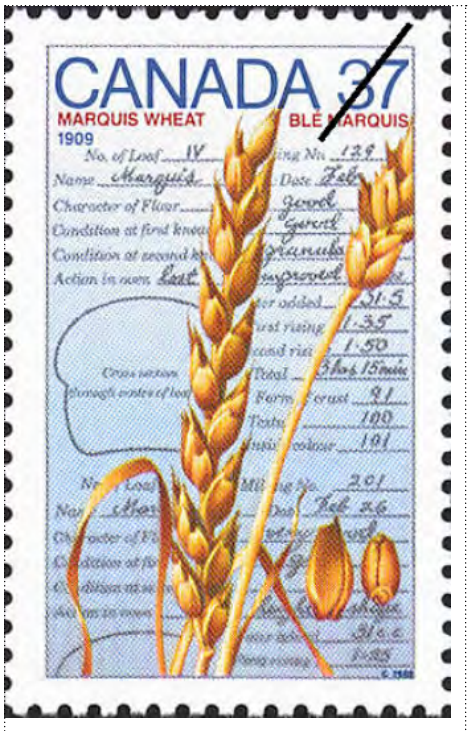

Photo: Library and Archives Canada; Copyright: Canada Post Corporation

Dr. Charles Saunders used selective plant breeding to experiment with seed varieties created by crossing Red Fife and another breed of wheat called Red Calcutta.

Once he had samples of strong heads of wheat, he would select kernels from those heads and chew them to make a dough ball. He assumed that the dough ball that had the most elasticity would have the most gluten strength, which would result in the largest loaf of bread.

This wheat was much **hardier** – it allowed farmers to plant it earlier and harvest it later and extended the growing season. When it was used with inventions like gas tractors and threshing machines, the production levels of wheat exploded.

In 1896, prairie farmers produced 8 million bushels of wheat. By 1911, that production rose to 231 million bushels. The photos show Red Fife and Marquis Wheat. Can you describe the differences?

Types of wheat

In Canada, large-scale wheat growing didn't occur until after the Prairies were settled in the 1800s. Hard wheat, such as Red Fife, Marquis, and Selkirk, earned Canada a position as the granary for Britain and many other European countries. [Hard wheat has hard kernels that are higher in protein and gluten.]

Today, most of the wheat grown in Western Canada is the hard Red Spring variety. Soft wheats, such as soft red and soft white, are primarily grown in Quebec and Ontario. [Soft wheat has softer kernels and is higher in starch and lower in protein.]

Many of the original wheat growers have passed on their farms to the next generations, while others branched out to organic farming and milling.

Why was Marquis Wheat an example of a Canadian innovation?

.....

.....

.....

.....

This grain in a field by Fort Saskatchewan was **stooked** – or set upright in a field with their heads together so they can dry.

Courtesy of Libraries and Cultural Resources Digital Collections, University of Calgary

What impact do you think Marquis Wheat had on western Canada's population growth? How do you think it affected urbanization in the prairies?

more crop innovation

Barley was brought to Canada in the 1600s by early European colonists. It was brought for malt. The first Canadian brewery was built in Quebec City in 1668. This grain crop was also widely used as feed for livestock.

From Technology & Innovation Branch of Alberta Agriculture and Food (2000). Irrigation in Alberta. Government of Alberta: Online. https://albertawater.com/learn-docs/demand/74-irrigation-in-alberta-technology-a-innovation-branch-of-alberta-agriculture-and-food-2000

Photo: Courtesy of Libraries and Cultural Resources Digital Collections, University of Calgary

Irrigation is also an innovation. It was an important part of the government's and the railway company's efforts to attract settlers to the west. In the late 1800s, settler farmers were already building their own irrigation systems. The photo shows an irrigated wheat and barley field in 1914.

The first large irrigation project – a large canal southwest of Lethbridge built in 1900 – made large areas of land suitable for farming.

Barley, like other crops, has more recently benefitted from modern farming innovations. For instance, if farmers didn't use pesticides to protect their barley from weeds, diseases and insects, they would only be able to produce about 25 percent of what they do now.

Precision agriculture is another modern technique that can help by using technologies – including GPS guidance, drones and sensors – to improve the efficiency of farming. These technologies mean that farmers can ensure precise application of pesticides on the crop and avoids overlap in the field.

Pulses are a crop grown in Canada that had their beginnings with Indigenous peoples. **Pulses** are the dry edible seeds of legumes. They include dry peas, beans, lentils and chickpeas. Dry beans were grown by different First Nations people across North America. Some types of pulses were believed to have been brought to Canada by early farmers. Dry beans have been grown as a commercial crop since the middle of the 1800s.

Pulses are a unique crop. First Nations farmers – and later early European farmers – found that these plants had the ability to partner with some soil bacteria to take nitrogen, an essential plant nutrient, from the air and make it available as a nutrient for other plants.

Soybeans, like pulses, are part of the legume family but are more of an oilseed. Soybean was first grown in Canada in 1893, but not in significant amounts until the late 1920s. The photo shows a field of irrigated soy beans, near Duchess, Alberta in 1942.

Photo: Courtesy of Libraries and Cultural Resources Digital Collections, University of Calgary

Field peas got their start in Alberta, not in Saskatchewan as many people have come to believe. It was lentils that got their start as a commercial crop in Saskatchewan.

Seed innovations

Changes in seed variations are an important innovation for crops.

Barley makes up the most varieties of seed samples held in the Plant Gene Resources of Canada. In the 1970s, old Canadian barley cultivars (plants bred by humans) and breeding material was collected. This collection was expanded with contributions from plant breeders, or collected from the plant's natural habitat, and now includes species of barley collected from over 100 countries.

A seed bank can be used to breed plants with specific traits that make a crop more tolerant of disease, pests or climatic conditions, like drought or cold. Some old varieties of seed may have characteristics that could be valuable in more modern times.

a made in Canada innovation

Rapeseed was another European crop that was brought to Canada. In 1936, an immigrant farmer from Poland started growing a small amount of rapeseed in his garden in Shellbrook, Saskatchewan. The Canadian government had already started to grow rapeseed on **experimental farms** established in the early 1900s. Experimental farms were working farms set up by the government so agricultural practices could be studied.

However, there was no established demand for rapeseed in Canada and little knowledge of how rapeseed could be used. The experimental farms had proven that rapeseed could be grown successfully in both eastern and western Canada.

The Saskatchewan farmer knew, however, that rapeseed had been used in Europe for hundreds of years and that oil made from rapeseed was a very good lubricant for steam powered machinery.

When World War II broke out, there was a critical shortage of rapeseed oil. The oil was urgently needed as a lubricant for the increasing number of steam engines in navy and merchant ships and on submarines.

When the need for more rapeseed oil became known, the Saskatchewan farmer increased his seed supply and sold it to his neighbours. The seed became known as "Polish rapeseed" in Canada.

How do you think the innovations involved in improving crop production supported early communities on the western prairies?

It wasn't until the end of World War II, when rapeseed oil was no longer needed as a lubricant, that the possibility of using it as a Canadian food was explored.

Over the next 20 years, traditional plant breeding modified the seed to reduce the levels of unhealthy fatty acids in the seed's oil, and of the glucosinolates in the remaining meal.

Traditional plant breeding has been used by farmers for years. Farmers saved seed from plants with desirable characteristics, like better flavour, for replanting. This resulted in new varieties of crops.

The result was a healthier vegetable oil for human consumption and a "tastier" animal feed in the meal. With the new defining profile, this seed became known as canola.

innovation during the Depression

After World War I, the price of wheat collapsed. This greatly affected farm families who depended mainly on their wheat crops.

The invention of combine harvesting technology in the 1920s combined the actions of **harvesting** – gathering the mature crop from the field – and **threshing** – separating the edible part of the grain from the straw. This made the harvest much more efficient.

Photo: Library and Archives Canada/PA-040497

The photo shows one of these machines being used in High Prairie in 1930. Many farm families borrowed to buy this and other types of new technology so they could increase the yield of their crops.

This time period in agriculture was one of **mechanized farming** – relying more and more on machines and equipment.

However, new ploughing technology also resulted in over working the soil, pulverizing it into fine particles. This left the soil vulnerable to drought and wind.

The dust storms that swept the prairies during the Depression forever changed farms and farming practices. When drought, grasshoppers and crop disease hit the prairies in the 1930s, farmers who could not grow enough crops to make a living lost their farms.

Some left behind farm equipment they had bought when grain prices were high, but could no longer afford to use. Farmers who had invested in automobiles found that they could not afford gasoline and went back to horse-powered transportation, many hitching their automobiles to the horses.

This innovative mode of transportation was called a Bennett buggy. It was named for R.B. Bennett, who was the prime minister between 1930 and 1935.

Photo: Courtesy of Libraries and Cultural Resources Digital Collections, University of Calgary

The loss of prairie topsoil during the dust storms and drought taught many prairie farmers hard lessons. Farmers started to pay more attention to soil stewardship practices.

- **Crop rotation** was not a new practice, but it was used with crops like soybeans and corn alternating with other grains.
- **Cover crops** – like legumes (including pulses), rye, oats and buckwheat – helped to recycle soil nutrients and were used to protect soil fertility.
- **No till farming**, which leaves the soil undisturbed after harvest, is used to avoid exposing the soil to wind and rain and help hold in moisture.

How do you think the conditions during the Depression might have motivated other types of innovation?

A pioneer's ingenuity: getting by during the Depression

Garnet Mclean and his wife moved to their homestead one mile north of Withrow in west-central Alberta in 1909.

The homestead was 160 acres of poplar trees along with the occasional willow bush. It was all cleared by hand with an ax and a grub hoe during the next 30 years.

The family consisted of two boys and a girl, with the older boy joining the Canadian armed forces in 1941.

It was impressive how Mclean improvised while fixing the wheel on his seed drill. Note how he used an old mower wheel, shaped wood around it and wrapped it with wire.

The Depression years of the 1930s forced farmers to be innovative while repairing their equipment, such as this wheel on Garnet Mclean's seed drill.

Photo and article excerpt from Duncan, J. (March 1, 2018). A pioneer's ingenuity: getting by during the Depression. Western Producer: Online. www.producer.com/farmliving/pioneers-ingenuity-getting-depression/

A Growing Opportunity: Skills, technology and the future

Visit a canola farm in Saskatchewan these days, and you may spot a seeder moving up and down the fields without a person in sight. The autonomous DOT platform is the latest disruptive technology to hit farming, and it won't be the last. The machine (named by the inventor after his mother, Dorothy) drives itself, tells the farm owner about soil conditions and reports back, in real time, how it's performing in the field.

DOT, which is made in Saskatchewan, is hyper-efficient and may seem like a job-killer. It is anything but. Look more closely at one of the fields where it's working, and you'll spot a couple of software engineers, giving chase, to monitor, update and occasionally debug the $500 000 contraption. It's just one illustration of the fourth agricultural revolution, which is already demanding new technologies and skills, a fresh management mindset and a more global outlook than the previous generations of food production ever harnessed. And here's the surprise: even as automation replaces the hard physical tasks that once defined farming, the human quotient in food production appears to be greater than ever.

In what ways could the use of robotic technologies and innovations have a similar impact as the replacement of horse-powered by fuel-powered farm machinery?

As we enter the 2020s, Agriculture 4.0 — powered by cognitive machines and a skills-savvy workforce — is starting to determine whether Canada can once again be an agriculture superpower, and do it in a way that feeds an ever-hungrier world, cuts greenhouse gas emissions, and supports thousands of communities that still help define our country. Coding at the farm gate is just one illustration of the skills revolution underway. Across the Prairies, there are geneticists helping farmers meet the surge in demand for plant-based proteins. In the Okanagan Valley, horticulturalists are working with drones and earth sensors to better program their irrigation systems. In the greenhouses of Ontario, mechanics are tooling robots to pluck berries, while people are being redeployed to optimize growing conditions with market conditions. And farther east, off the coast of Atlantic Canada, lobster crews are working with sensors in underwater traps to gauge the environmental conditions of their catch, and ensure the data moves quickly into the systems of buyers around the world.

Excerpted from RBC Thought Leadership (August 2019). Farmer 4.0: How the coming skills revolution can transform agriculture. Royal Bank of Canada. www.rbc.com/economics/economic-reports/pdf/other-reports/Farmer4_aug2019.pdf