How do biodiversity and climate change shape smart agriculture solutions?

To some, the term "climate change" can feel like a buzzword or trend that is associated with primarily negative effects. **Climate** refers to the average weather conditions in an area over a long period of time — scientists generally use a measurement of an area's weather conditions over 30 years or longer. An area's climate includes systems in the air, water, land and living organisms.

Climate change is the shift or abnormal change in climate patterns. As the planet warms faster than the average weather conditions, climate patterns in regions around the world fluctuate. Ecosystems and biodiversity are affected by these longer-term changes.

Changes in climate affects both humans and animals. It can intensify droughts, decrease water supply, threaten food security, erode and threaten coastlines and weaken natural resilience in plant and animal species that people depend on.

More than 40 scientists worked on a report from Environment and Climate Change Canada. This 2019 report highlighted two recent extreme weather events in Alberta: the 2013 floods in the province's south and the Fort McMurray wildfires in 2016. They assessed the extent to which human influence on the climate may have played a role in such catastrophic events. The report found:

- It is **virtually certain** that Canada's climate has warmed and that it will warm further in the future. Both the observed and projected increases in mean temperature in Canada are about twice the corresponding increases in the global mean temperature.

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What evidence suggests our climate is changing?

- While both human activities and natural variations in the climate have contributed to the observed warming in Canada, the human factor is dominant. It is **likely** that more than half of the observed warming in Canada is due to the influence of human activities.
- There is **medium confidence** that annual mean precipitation has increased, on average, in Canada, with larger percentage increases in northern Canada.
- For Canada as a whole, observational evidence of changes in extreme precipitation amounts, accumulated over periods of a day or less, is lacking. However, in the future, daily extreme precipitation is projected to increase (**high confidence**).

Environment and Climate Change Canada (2019). Canada's Changing Climate Report. Government of Canada: Online. https://changingclimate.ca/site/assets/uploads/sites/2/2019/04/CCCR_FULLREPORT-EN-FINAL.pdf

agricultural biodiversity

The conservation of agricultural biodiversity on farms and in natural ecosystems is an important part of adapting to climate change. The management of livestock that are either rare or threatened with extinction maintains the genetic diversity of animal breeds. **Genetic diversity** refers to the variety of genes contained in plant and animal species. It occurs with the different breeds in a species as well as between species. For example, Holstein, Jersey, Ayrshire and Hereford are all cattle breeds, but they look different and produce different yields of milk.

Some breeds, like Holsteins, produce more milk, while others produce less milk but more **butter fat** – the cream content of their milk. Some cattle breeds are more suitable for beef production instead of milk production. For example, Angus cattle produce better meat, but are not efficient at producing milk.

Biodiversity in agricultural ecosystems has been shaped by farmers and communities for thousands of years. It is an important resource for the continued improvement of varieties and breeds and needed to cope with changes in climate.

Climate Change and Biodiversity

At FortWhyte Alive's solar-powered farm, young people are coming together to fight climate change, restore habitat and encourage biodiversity. The centre strives to connect humans with nature through a variety of unique programs and events that foster sustainability in the community.

One of FortWhyte Alive's newest programs, the solar farm is a model for how urban agriculture can be used to educate young people, foster community, and reduce greenhouse gas emissions. And as a social enterprise, the revenue generated by the farm is put back into the community. "We grow youth, food, and community," summarizes FortWhyte Farms Manager, Dannielle Mondor.

The most visible feature of the farm is a large bank of solar panels. It's actually the largest installation of solar panels in Winnipeg. "You have solar panels, native prairie plants, wild pollinators and honeybees all in one space, working together. It's a really neat example of what real action toward fighting climate change and investing in biodiversity can look like," says Mondor.

This is a "good news" story and great example of how people in communities across the country are coming together to fight climate change and make a difference – one small action at a time.

Climate Atlas of Canada. FortWhyte Alive: Solar Powered Farming: Online. https://climateatlas.ca/video/fortwhyte-alive

The Climate Change and Biodiversity story comes from Manitoba. How do you think their practices could be applied to agriculture in Alberta?

Agriculture and wildlife: A two-way relationship

Agricultural land provides important habitat to a variety of wildlife species, with natural land for pasture, woodlands and wetlands having the highest habitat value. Wildlife supplies many ecosystem services to the Canadian agricultural industry, and Canadian farmers can adopt several agricultural practices that enhance wildlife habitat.

- **In 2011, nearly one-third (30.2%) of agricultural land in Canada was wildlife habitat, which represented 19.6 million hectares.**
- **Three-quarters of wildlife habitat reported by Canadian farmers was natural land for pasture (75.0%), and the remainder was woodlands and wetlands (25.0%).**
- **Two in five farms (40.3%) reported natural land for pasture while one in two farms (49.9%) reported woodlands and wetlands in 2011.**

The relationship between agriculture and wildlife is a complex blend of cooperation and challenges. As agricultural land and wildlife habitat are converted for other uses, the co-existence of agriculture and wildlife could become increasingly important.

Jeswiet, S. & Hermsen, L. Agriculture and wildlife: A two-way relationship. Statistics Canada: Online. www150.statcan.gc.ca/n1/pub/16-002-x/2015002/article/14133-eng.htm

climate and the food supply

Climate variability has a direct impact on food availability and quality. Extreme weather events can affect food production and increase the need for more food imports. Food prices can vary following shortages and climate extremes. Food safety can be compromised because of crop contamination, and outbreaks of pests and diseases can occur because of rainfall intensity or rapid changes in temperature.

The opposite also applies. Climate is affected by human and natural factors. **Natural factors** include changes in ocean currents, changes in solar radiation and natural events like volcanic activity. **Human factors** include increases in concentrations of greenhouse gases, mainly from burning fossil fuels, which trap heat within our atmosphere, and the use of forests and wetlands for agricultural, residential and industrial uses. These human activities have an influence on physical, chemical and biological interactions between the Earth's surface and the atmosphere. These interactions affect air temperature and precipitation.

Agriculture and climate

Farmers know all too well that agriculture is highly dependent on weather. Modern methods, techniques, and technologies have made today's crop and livestock farms increasingly productive, but agricultural success still depends on getting just the right amount of rain and just the right amount of heat and sunlight at just the right time of year.

- **The planting, maturing, and harvesting of crops all depend on consistent seasonal patterns.**
- **Livestock depend on feed, water and a tolerable range of heat and humidity for healthy, productive growth.**
- **Climate helps determine which pests and diseases will spread, and so how much time, effort, and money farmers must spend on herbicides, insecticides and other defences.**

- **Beyond the harvest, patterns of temperature and weather affect the entire supply chain of storage and transportation that brings food from the field to the dinner plate.**

From the largest farm to the smallest market garden, from planting to eating, and at every stage in the cycle of production — from choosing seed to transporting livestock — agriculture and agri-business thoroughly depend on climate. And the climate is changing.

Climate Atlas of Canada. Agriculture and Climate: Online. https://climateatlas.ca/agriculture-and-climate-change

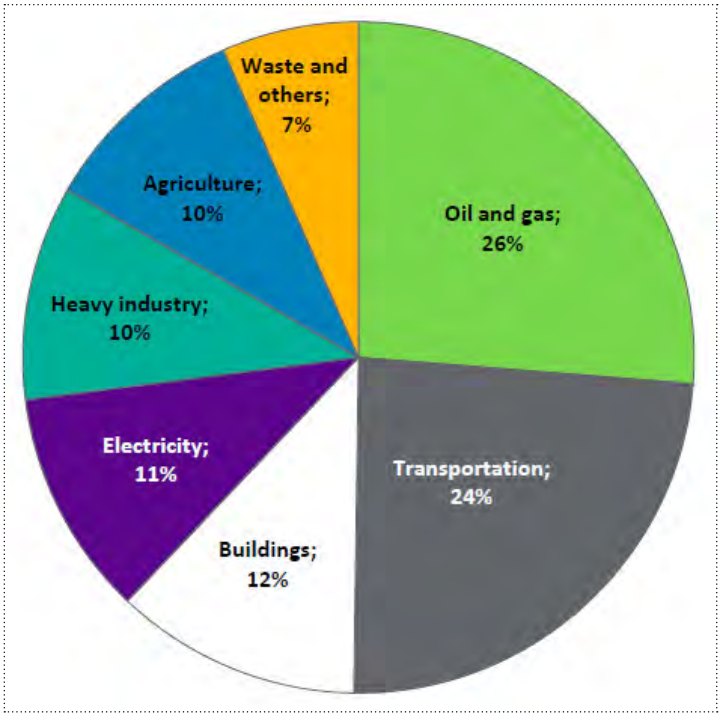
What comparisons can you make between Canada's and Alberta's greenhouse gas emissions?

the challenge of greenhouse gas

Greenhouse gas (GHG) emissions are generated by many human activities. Those generated by agricultural activity come in three main forms: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

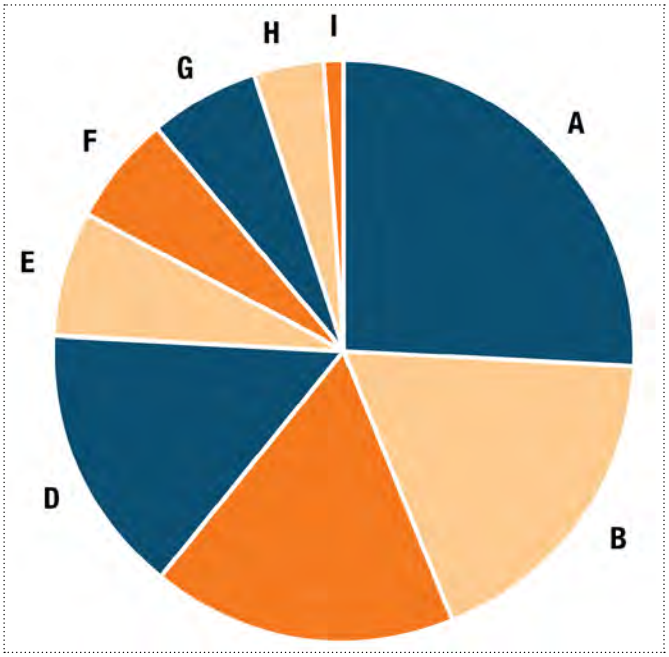
Globally, agriculture emits about 13 percent of total GHG emissions. Emissions from agriculture accounted for approximately 8.5 percent of total GHG emissions for Canada in 2016.

Canada's emissions 2016



House of Commons (2018). Toward a Resilient Canadian Agriculture and Agri-Food System: Adapting to Climate Change. Government of Canada: Online. www.ourcommons.ca/Content/Committee/421/AGRI/Reports/RP9814809/agrirp11/agrirp11-e.pdf

Alberta's emissions 2018



	Emission source	Percentage
A	Oil sands (mining, in situ and upgrading)	26
B	Electricity / heat generation	18
C	Oil and gas and mining	17
D	Transportation	15
E	Agriculture	17
F	Residential / commercial	6
G	Manufacturing / construction	6
H	Industrial	4
I	Waste	1

Government of Alberta (2018). Climate Change in Alberta. Online. www.alberta.ca/climate-change-alberta.aspx

Farming livestock — cattle, sheep, goats, pigs and chickens — contributes around 6 billion tonnes of greenhouse gases globally to the atmosphere each year.

However, the livestock sector also offers great benefits. It includes 20 billion animals, supports 1.3 billion farmers and retailers, and contributes up to half of the economic product from agriculture. According to the Food and Agriculture Organization of the United Nations, the global consumption of meat, milk and eggs is projected to grow 70 percent by 2050, mostly in the developing world.

According to Agriculture and Agri-Food Canada, measuring emissions of GHGs from farms is not easy; emissions come from many places on the farm: soils, animals of all kinds and machinery. To capture these emissions, scientists have devised a host of methods:

- Small collection chambers placed on soils, or large collection chambers placed on cow, or other animal, housing
- Instrumented towers downwind of fields or instrumented aircraft flying over farming regions
- Methods that require patient analysis of carbon change in soils over tens of years
- Measurements of carbon dioxide (CO_2) in air, several times a second
- Analysis of air in tubes buried in the soil, or from tubes hung high in the air on balloons

No method is perfect, but each has its role. By pooling results from all methods, scientists obtain reasonably good estimates of emissions and the factors that control them.

Agriculture and Agri-Food Canada (2016). Measuring Emissions. Government of Canada: Online. www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/climate-change-and-agriculture/greenhouse-gases/measuring-emissions/?id=1329321977257

What are some global statistics? Around 1.6 to 2.7 billion tonnes of greenhouse gases each year, mostly methane, are produced from livestock digestion. Another 1.3 to 2 billion tonnes of nitrous oxide come from producing feed for livestock. And the final 1.6 billion tonnes comes from land use changes, such as clearing for animal pastures.

Eat less meat?

The elephant in the room is whether we should be looking to transition away from eating meat. We found that, in theory, this practice could mitigate up 5 to 6 billion tonnes of greenhouse gas emissions in the most extreme scenarios.

But as with many interconnected systems there is rarely an easy answer. In the developing world for instance, where lack of some nutrients — and too many of others — can occur at the same time, the problem is more complex. The question becomes about who keeps on eating and who should reduce consumption, and which products and where.

-Mario Herrero, Chief Research Scientist, Food Systems and the Environment, CSIRO

Herrero, M. (2016) To reduce greenhouse gases from cows and sheep, we need to look at the big picture. The Conversation: Online. https://theconversation.com/to-reduce-greenhouse-gases-from-cows-and-sheep-we-need-to-look-at-the-big-picture-56509

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How would you graph the global statistics for GHG emissions? List the statistics you would use to make comparisons.

Emissions from livestock production vary across the globe. The developing world accounts for 70 percent of emissions, mainly because of the large numbers of animals used for a variety of purposes — like tilling , clearing, transport and packing — beyond the production of meat, milk and eggs.

Some believe that emissions from livestock could be reduced by around 2.4 billion tonnes of greenhouse gases each year through technology and management.

Achieving these savings will be dependent on improvements in feeding practices, such as better pastures, new types of food and more grains. It will also depend on improved ways of handling manure, and improved genetics and animal management . Many of these strategies are based on sustainable practices, like producing more livestock protein with fewer resources and storing carbon in the land.

Consider the impact that smart agriculture practices may have on greenhouse gas emissions in the Q & A that follows.

What are the risks in using estimates to identify GHG emissions?

smart agriculture Q & A

What are best practices?

Best practices are methods or techniques that have consistently shown positive results. An example of a best practice would involve making use of manure from livestock production to increase soil nutrients for crops.

Emissions could be reduced by implementing best practices. These best practices are identified by looking at what farmers, who show the lowest emissions within an area or agricultural zone, do on their farms.

Why can best practices for smart agriculture be identified from farmers who have the lowest emissions? What would be required to identify these farmers?

Why should precision feeding be used?

Precision feeding can be a highly effective tool in enabling a reduction of feed intake per animal while also maximizing individual growth rates. It enables the provision of the right amount of feed, in the right nutrient composition, at the right time, and for each animal individually. Emissions could be reduced by a widespread implementation of precision feeding.

How does food waste produce emissions?

About a third of all food produced for human consumption is lost or wasted. According to the Food and Agriculture Organization of the United Nations (FAO), food loss and waste accounts for about 4.4 billion tonnes of greenhouse gas emissions per year. Food waste goes into landfills, where it decomposes and releases methane, a greenhouse gas that is at least 28 times more potent than carbon dioxide.

Smart waste management offers high potential to first identify causes of lower quality food, which add to food waste. Second, smart waste management has potential to improve existing processes and decrease waste amounts. Emissions could be reduced by minimizing food waste with the help of technologies.

How is animal health and the environment protected at the same time?

Disease can decrease production efficiency of livestock by up to 33 percent. The trend towards more and more intensification of livestock farming systems increases productivity. However, larger farms also mean that a disease outbreak could result in a loss of more animals and the potential of decreased biodiversity.

A larger number of smaller farms can protect biodiversity, but also requires more land and increased need for transportation, which in turn can increase emissions. Emissions could be further reduced by the installation of smart animal health monitoring techniques.

What decisions are made when transporting food?

Food products often travel long distances to reach consumers. The movement of food is complex — it happens through ships, trains, trucks, planes and warehouses and often requires special packaging and storage. The food chain can be challenged by seasonality, freshness, spoilage, sanitary and food safety considerations.

How does food movement and transportation impact greenhouse gas emissions? International water shipments of food have the lowest impact, followed by inland water routes and rail. Trucking produces 10 times more greenhouse gas emissions per tonne than water shipping. Air transportation is 40 times higher — faster transportation methods produce more greenhouse gas emissions.

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Did you know that if food loss and waste were represented by its own country, it would be the world's third-largest country for waste emissions? What types of technologies do you think would help minimize food waste?

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Faster food transportation methods reduce food waste. Slower methods may produce lower emissions but increase food spoilage and waste. How do you think decisions about transportation should be balanced?