Artificial Intelligence (AI) for Plant Protection: Current and future directions for Agriculture and Agri-Food Canada

NAPPO

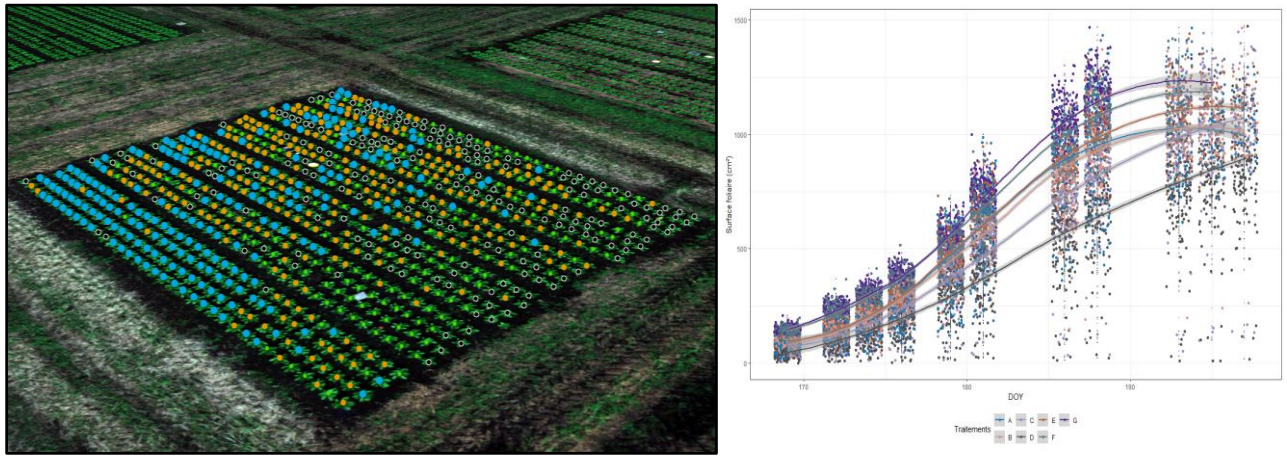
October 23rd, 2025

Dr Etienne Lepage

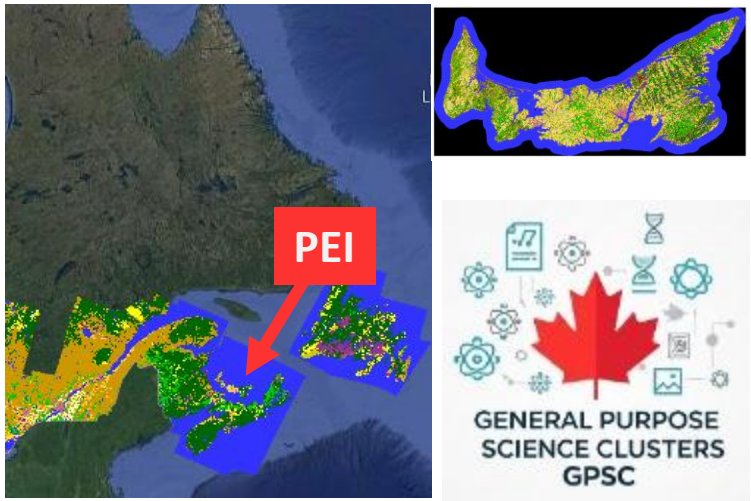
Canadian Smart Digital Agriculture

Digital Agriculture is the application of **data-driven decisions using data from multiple sources** including connected sensors (Internet-of-Things, IoT) unmanned aerial vehicles (UAVs), and robotics.

- Since 2016, the Government of Canada (GoC) has announced over $4.4 billion to support Artificial Intelligence (AI) and digital research infrastructure.
- Smart agriculture use developed AI models to help improve management of field operations, aiming towards more sustainable and profitable allocation of agriculture resources.



Follow individual horticultural plant growth trajectories for targeted field operations
Project J-002302 – IRIA/PlantDynasty



J-003229 - Dre Catherine Champagne teams

Data Initiative as a Foundational Asset

Canada is a data-rich nation and having **high quality, proprietary, annotated data** is critical to ensure the validity and ownership of the created generative AI models and their outputs.

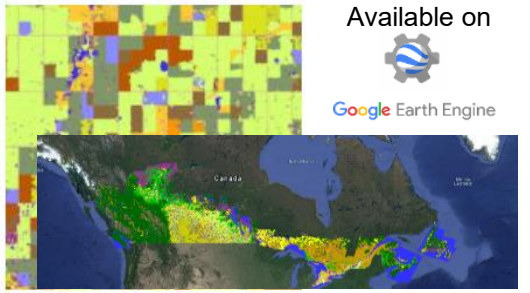
- ***Any bias in the training data can hinder a model's ability to give the right answer.***

Investment of $30 million a decade ago in the BioMob project , which captured and imaged over 3.5 million specimen records and 1.4 million new specimen images biological collections (2016 to 2022), helped jump-start the capacity of AAFC to create the next generation AI models.

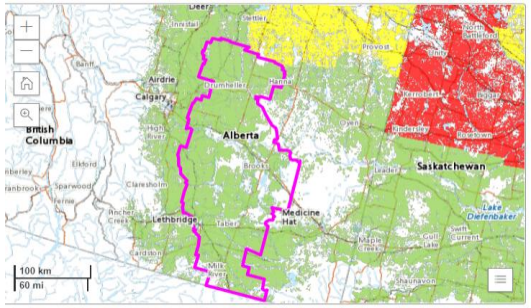
youtu.be/4xoQR6jSVeA

Robotic platform for digitalization

Open data is critical in AAFC strategy for improving global agriculture. Different geospatial data layers are publicly accessible through private platforms such as Google Earth Engine or through the Canadian Open data platform (open-science.canada.ca).



AAFC Annual Crop Inventory



AAFC Crop Yield Forecasting

https://agriculture.canada.ca/en/science/collections
https://open-science.canada.ca

AI in Action for Plant Protection

Here are some examples of AAFC's use of computational resources and AI models for new research opportunities.

Automated research platform to identify early sign of stress Project J-003163 - AI platform

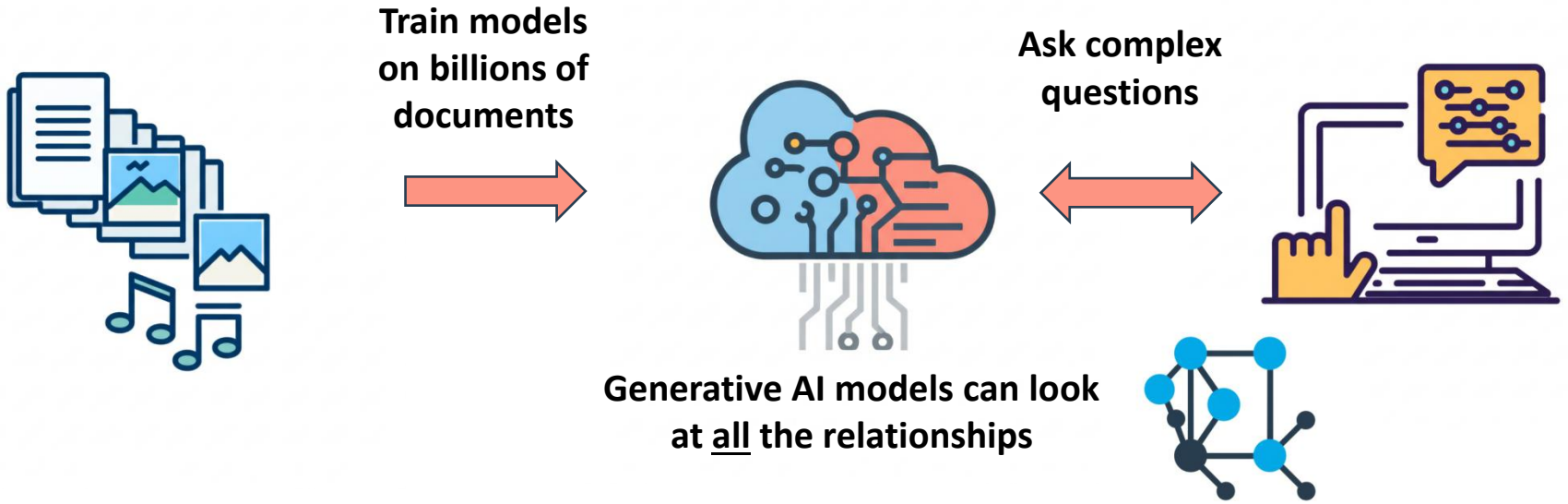
The **weed sentinel project uses AI to identify the critical weed management window** early in the growing season. Furthermore, development of Canadian specific weed AI models using the captured images will be used in the next generation of agricultural robots and to rapidly assess the impact of new biopesticides.

J-002848 – Internet of weed sentinels

Generative AI Models

Generative AI models are a recent development in Machine Learning specializing on content creation.

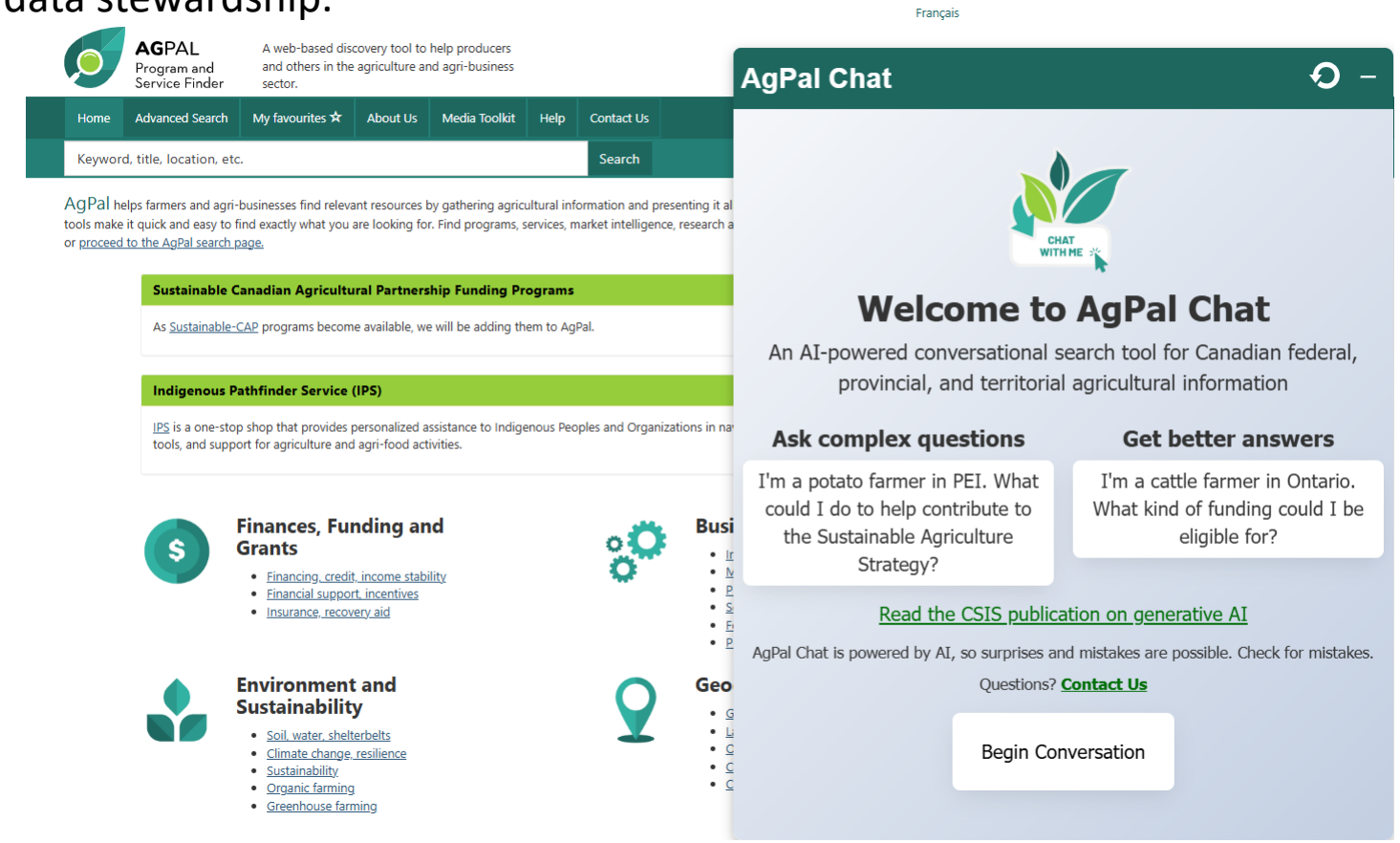
- They are trained from collections of billions of text documents, pictures or sounds.
- Generative models excel at linking together different concepts in a hierarchy, allowing the exploration of high-dimensional and non-linear data. While some relationships might be overlooked by scientists and practitioners, **generative models are able to explore multiple relationships and their interactions** to propose some plausible solutions to problems, allowing faster, new and uncommon discovery.



Translating science into impact

Applications of generative AI can help scientists for common desk tasks such as summarizing information or producers to access the AAFC's extensive knowledge base.

- This is the direct consequence of AAFC and the GoC federal public strategy (2025-2027) into its digital infrastructure and data stewardship.



The interactive chatbot "agpal.ca" help producers and agri-businesses to find information using their own natural language. This intelligent system provides seamless access to over 3,000 services from federal, provincial, territorial, and municipal programs. It helps locate scientific literature, business practices, specific regulations and support information available through different GoC web portals.

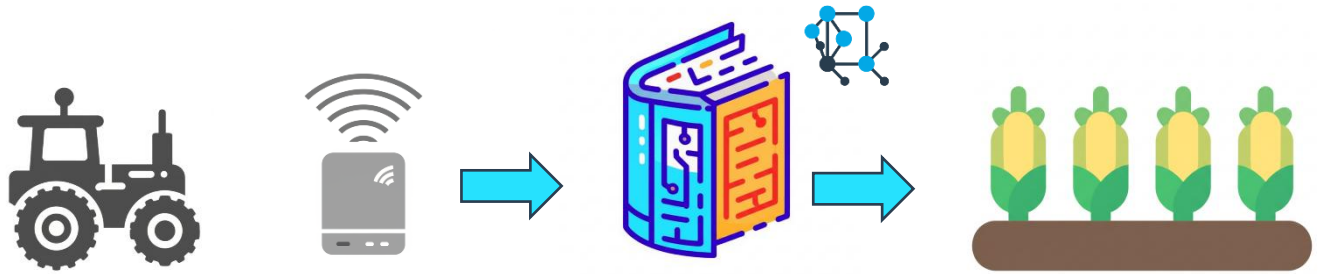
https://www.canada.ca/en/government/system/digital-government/digital-government-innovations/responsible-use-ai/gc-ai-strategy-overview.html

Future directions

Some aspects of Generative AI needs to be investigated:

New massive datasets are being collected.

- Capturing data is dramatically changing in the agriculture ecosystem. Multiple connected devices, sensors and even robotic platforms are being deployed in agricultural fields, capturing real time data at a fine spatial resolution.
- Linking together those data sources are critical for the agriculture of the future.
- Generative AI could be one of the tools rapidly transforming this linked data into insight for Canadian producers such as rapidly integrating different results into comprehensive reports, or even performing themselves some of the data curation, data analysis and data interpretation.



High spatial and temporal resolution

Generative AI models as « books of the future »

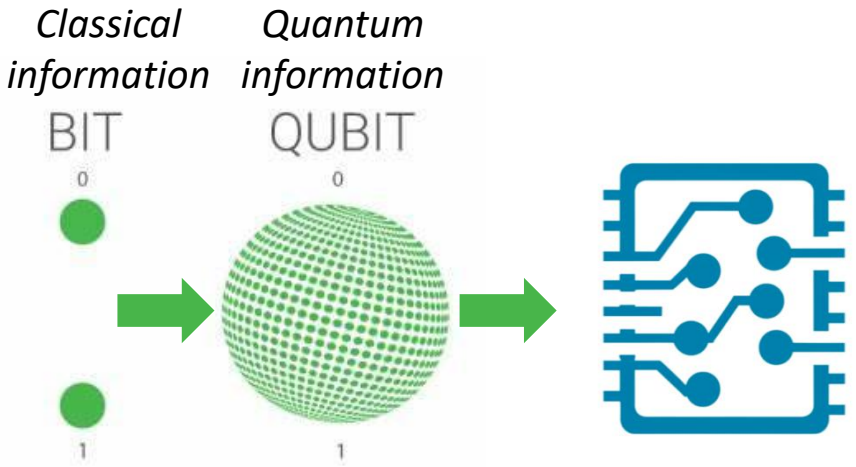
Insight to producers

4. Future directions

Some aspects of Generative AI needs to be investigated:

Creating generative AI is costly and required significant computational resources.

- Quantum computers are being deployed across Canada and within the GoC computer network to enable researchers to gain a deeper understanding of this emerging technology. These advanced computing systems and new software programming paradigm offer the potential to accelerate both AI model development, and data analytics with low energy consumption.
- Currently, a project (QRDI, 2023-2028) is exploring quantum computing to understand how this technology can enhance data security (cryptography) and expedite the processing of existing data through the development of new algorithms.



Quantum computers currently require hand-crafted novel algorithms to profit from the quantum advantages over current machine learning hardware and applications. Different Canadian quantum computers created by *Xanadu* and *D-Wave* are being explored for specific use cases by AAFC.

Acknowledgements

Presentation – Etienne Lord, Research Scientist, AAFC
Revision and comments - Étienne Lepage , SPID/PPD, AAFC
Revision and comments - Anne-Michelle Bareil, SPID/PPD, AAFC
Revision and addition – Muhammad Tufail, Research Scientist, AAFC

All illustrative images, except research results and photographs, were created using Google Gemini via the GoC Radia AI platform.