Investing in Canada's Smart Agriculture

By: Gianna Binder
Department of Electrical and Computer Engineering
University of Waterloo
Waterloo, Canada
gbinder@uwaterloo.ca

For: Marie Claude Bibeau
Ministry of Agriculture and Agri-Food
Government of Canada
Ottawa, Canada
Marie-Claude.Bibeau@parl.gc.ca

***Abstract*—The climate crisis and projected increase in global population call for an increase in food production. However, Canada's agriculture sector is short of labour, and current agricultural practices face challenges which cannot meet these demands. Smart farming increases crop production efficiency and sustainability. However, implementing AI technologies may harm independent farms and workers. The Ministry of Agriculture and Agri-Food should allocate a significant sum of money to smart agriculture technologies in independent farms for the following five years while ensuring agribusinesses do not take advantage of farmers.**

Keywords—agriculture, agribusiness, artificial intelligence, farming, smart agriculture, sustainability

I. Policy Recommendations

To address the vacancies in Canada's agriculture industry and the projected international population and environmental forecast, the Ministry of Agriculture and Agri-Food (MAAF) should invest significant money to support independent farmers through smart agriculture technologies for the following five years. Additionally, the Ministry should enforce a policy to ensure agribusinesses do not use AI unscrupulously against farmers.

II. Introduction

The agriculture sector is an integral part of Canadian society. The industry provides food to the population and raw materials for industries and is responsible for 6.8% of our gross domestic product as of 2022 [1]. Foreign countries rely on Canada's agriculture sector as well. Canada is "the fifth-largest exporter of agri-food [...] in the world" [1]. Moreover, agriculture "is one of [Canada's] sectors with the highest economic potential" [1]. Thus, the prosperity of Canada's agriculture sector is crucial. However, Canada's food production is at risk, with agriculture companies reporting vacancies above 20 percent since 2019 [2]. Moreover, as the global population is projected to reach 9.7 billion by 2050, food production needs to increase by 70% [3]. Unfortunately, limited natural resources, the climate crisis, and the industry's current unsustainable practices [4] raise concerns about meeting these demands. This propagates a need for innovation within the industry to optimize food production, processing, and sustainability. By integrating Artificial Intelligence (AI) within agriculture, Canada can achieve this [5] while ensuring its "sector is competitive, sustainable, resilient, and prosperous well into the future" [1].

A. Technical Terms

- Smart agriculture: the use of technologies such as AI, robots, and sensors in farming
- Agribusiness: companies which produce equipment and materials for farming

III. Methods

[6], [7], and [12] were evaluated using the RADAR framework and selected from the University of Waterloo's

Omni database. [1], [2], [3], [4], [5], [9], [10], and [11] were chosen from government websites, scientific journal publishers, and university-published articles as they are reputable sources.

IV. Research

A. Challenges of Traditional Farming

Traditional farming is meticulous. Farmers must monitor their land strictly to ensure it is optimal for cultivation. For example, they must monitor the properties of their soil. The soil's properties are measured in a lab. However, labs may not provide farmers with sufficient data and sometimes are inaccurate [6, p. 3667]. Both are lengthy and difficult processes which AI-driven sensors can simplify. Some prominent monitoring technologies in the field of agriculture include soil nutrient sensors, water sensors, and biosensors [6, p. 3667], a type of sensor which detects diseases in crops and soil [7, p. 990]. Data the sensors collect are sent to farmers [7, p. 990] and are also used in Data Analytics to identify future problems and address them early [6, p. 3667].

Agricultural robots and drones can also take the physical burden off workers. They can be programmed to examine the land and automate repetitive and intensive tasks [7, p. 993]. Such tasks include crop monitoring, waste reduction, security, harvesting, weed control, and irrigation [7, p. 993]. Robots and drones can also receive data from sensors and address the situation appropriately [7, p. 993].

B. Unsustainable Practices of Traditional Farming

Current farming practices are damaging to the environment. In 2019, the agriculture sector produced "approximately 10% of Canada's greenhouse gas (GHG) emissions" [8]. Synthetic fertilizer accounts for roughly 17% of these emissions [8]. This can be related to Western Canada's increased use of phosphate fertilizers which has been rising by 6% annually since 2011 [9]. Phosphate is a GHG—excess GHG emissions are "the dominant cause of [global warming]" [10]. The use of nitrogen fertilizers has also increased by 134% in the past decade [9]. Although nitrogen is not a GHGs, it is detrimental to the environment. These fertilizers contaminate aquatic systems, which kills aquatic life and poisons drinking water [11]. Using AI technologies can minimize the deposits of fertilizers by accurately assessing the exact amounts needed by crops [7, p. 989].

[12] is also a research paper referenced. [12] is addressed in the Discussion section.

V. Discussion

In traditional farming, human labour is required at every stage. This increases cost, time, and "probability of error and waste which [...] impacts crop quantity and quality" [7, p. 985]. AI technologies in the sector help farmers monitor their land to improve production [6, p. 3667] and optimize resources by using tailored measurements [7, p. 984]. Smart agriculture has been shown to make food production more cost- and time-effective [6, 3667].

A. Social Issues

Due to AI's advantages, workers can lose their jobs to technology. This "may result in higher levels of unemployment in rural areas [...] and [an] increase in the

power of employers to dictate the wages and conditions" of their workers [12, p. 12].

Moreover, smart agriculture may create a divide in the industry. Industrial farms will have more resources to invest in AI technologies and, consequently, will progress much faster than family-run farms. This can push independent farmers out of business [12, p.10].

B. Ethical Issues

Another concern of implementing an AI system centers around ownership of the data it receives [12, p. 12]. Agribusinesses may take control of the data and utilize it to benefit themselves at the farmer's expense [12, p.10]. For example, they could sell the data to competing farmers [12, p.10].

C. Legal Issues

Agribusinesses can also legally bind farmers to use their products. For example, Pioneer requires that farmers use their AI systems with their seeds [12, p. 10]. If the farmer is dependent on Pioneer's AI, it becomes difficult for them to use another company's seed which may benefit them more [12, p. 10].

VI. CONCLUSION

Although implementing AI systems in agriculture has various social, ethical, and legal harms, its benefits regarding our social and environmental forecast are significant. Canada's food production must increase. Amid current labour shortages in the sector, smart agriculture is the only viable option. To protect independent farmers from the competition of industrial farms and establish themselves in the future of agriculture, the MAAF should support their investment in smart technology for the next five years and enforce a policy to ensure agribusinesses do not use AI dishonestly against farmers.

REFERENCES

[1] "Overview of Canada's Agriculture and Agri-food Sector." Government of Canada. https://agriculture.canada.ca/en/canadas-agriculture-sectors/overview-canadas-agriculture-and-agri-food-sector (accessed Oct. 29, 2022).

[2] R. Black. "Labour Shortage Threatens Canada's Food Supply Chain: Senator Black." Senate of Canada. https://sencanada.ca/en/sencaplus/opinion/labour-shortage-threatens-Canada'-food-supply-chain-senator-black/ (accessed Nov. 11, 2022).

[3] G. Silva. "Feeding the World in 2050 and Beyond – Part 1: Productivity Challenges." Michigan State University. https://www.canr.msu.edu/news/feeding-the-world-in-2050-and-beyond-part-1 (accessed Nov. 8, 2022).

[4] T. E. Crews, W. Carton, and L. Olsson, "Is the Future of Agriculture Perennial? Imperatives and Opportunities to Reinvent Agriculture by Shifting From Annual Monocultures to Perennial Polycultures," *Cambridge University Press*, vol. 1, Nov. 2018, doi: https://doi.org/10.1017/sus.2018.11

[5] V. Sharma. "Methods and Techniques for Soil Moisture Monitoring." The University of Wyoming. https://wyoextension.org/publications/html/B1331/ (accessed Nov. 9, 2022).

[6] D. R. Vincent, N. Deepa, D. Elavarasan, K. Srinivasan, S. H. Chauhdary, and C Iwendi, "Sensors Driven AI-Based Agriculture Recommendation Model for Assessing Land Suitability," *MDPI*, vol. 19, pp. 3667-3683, Aug. 2019, doi: 1033.90/s19173667.

[7] S. Katiyar and A. Farhana, "Smart Agriculture: The Future of Agriculture using AI and IoT," *Journal of Computer Science*, vol. 17, no. 10, pp. 984-999, Nov. 2021, doi: 10.3844/jcssp.2021.984.999.

[8] "Discussion Document: Reducing Emissions Arising from The Application of Fertilizer in Canada's Agriculture Sector." Government of Canada. https://agriculture.canada.ca/en/about-our-department/transparency-and-corporate-reporting/public-opinion-research-and-consultations/share-ideas-fertilizer-emissions-reduction-

target/discussion-document-reducing-emissions-arising-application-fertilizer-canadas-agriculture-sector (accessed Nov 11, 2022).

[9] "Canadian Fertilizer Production, By Product Type and Fertilizer Year, Cumulative Data (x 1,000)." Statistics Canada. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210003701 (accessed Nov. 11, 2022).

[10] "Greenhouse Gas Emissions: Drivers and Impacts." Government of Canada. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions-drivers-impacts.html (accessed Nov. 11, 2022)

[11] A. G. Good and P. H. Peatty, "Fertilizing Nature: A Tragedy of Excess in the Commons," *PLoS Biol.*, vol. 9, doi: 10.1371/journal.pbio.1001124

[12] M. Ryan, "The social and ethical impacts of artificial intelligence in agriculture: mapping the agricultural AI literature," *AI & Society*, vol. 37, no. 3, Jan. 2022, doi: 10.1007/s00146-021-01377-9.

Note: The page range for [4] and [11] could not be found.