Case Study: Dairy Robotics

March 2024

A case study prepared for Remote controlled: The impacts of disruptive technologies in the Ontario agriculture sector

Case Study:
Dairy Robotics

March 2024

Mariam Rana
MES Student in Sustainability Management
School of Environment, Enterprise and Development
University of Waterloo
mm5rana@uwaterloo.ca

McKenzie Huneke
PhD Candidate in Sustainability Management
School of Environment, Enterprise and Development
University of Waterloo
m2huneke@uwaterloo.ca

Heather M. Hall
Associate Professor | Academic Director
Master of Economic Development & Innovation Program
School of Environment, Enterprise and Development
University of Waterloo
h.hall@uwaterloo.ca

Tara Vinodrai
Associate Professor | Director
Masters of Urban Innovation Program
Institute for Management and Innovation
& Graduate Department of Geography and Planning
University of Toronto
tara.vinodrai@utoronto.ca

Funding Acknowledgement: The project was funded by the Agricultural Research Institute of Ontario (ARIO) and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

Acknowledgements

We would like to thank the following graduate students and other highly qualified personnel who assisted with this project: Ben Shantz, Joelena Leader, Romaine Redman, Marina Mato, Mariam Rana, Mithara Fonseka, and Amaryah DeGroot. We would also like to thank the members of our Advisory Committee and the key informants who participated in the research for sharing their time and expertise.

About the Project

This case study is part of the *Remote controlled: The impacts of disruptive technologies in the Ontario agriculture sector,* which includes 48 key informant interviews with 52 key informants including agricultural industry experts, agricultural-related technology companies, and agricultural business experts to understand AgTech adoption in Ontario. For more information, please visit our project website.

Dairy Robotics

Dairy robotics technology has revolutionized dairy farming by automating many complex and repetitive tasks, giving farmers more control over milk production and processing.[i,ii] Dairy robotics systems include robotic milking, automation technologies for milk processing and dairy farm operations, and monitoring technologies for animal health.[iii] These systems integrate a range of components, including individual milking stalls, teat preparation mechanisms, a dedicated robotic arm, a milking apparatus, and control systems outfitted with cameras, sensors and software.[iv] Current technologies use a robotic arm to attach teat cups to a cow's udder in a sanitized manner. Each cow is identified using either computer vision, sensors, or electronic tags, which enable the tracking of milking frequencies, yields, and health metric information that farmers can view remotely on a phone, tablet, or computer.[v]

The first commercial robotic milking system was introduced by the Dutch company Lely[vi] in 1992. Since then, dairy robotics have advanced because of collaborations between researchers, dairy technology companies, and farmers.[vii] Advances in automation, data analytics, and sensor technology have greatly enhanced the efficiency and capabilities of these dairy robotics systems.[viii,ix] In addition, growing demand for dairy products and a shift towards more sustainable and efficient farming practices have spurred the ongoing development and refinement of robotic milking technologies.[x]

A Focus on Ontario

Dairy farming is the largest sector within Ontario's agriculture industry, involving 3,273 farmers across the province.[xi] Dairy milk in Ontario is purchased from farmers by the Dairy Farmers of Ontario (DFO), the industry's provincial marketing board. DFO then sells milk to dairy processors. DFO maintains a quota-based system intended to stabilize farmer revenue and help protect the sector against overproduction.[xii] Recent data shows a substantial rise in dairy robotics adoption rates in Ontario. Between 2016 and 2021, the number of farms using dairy robotics more than doubled from 337 farms to 715 farms.[xiii,xiv] In fact, the livestock sector leads robotics adoption in Canadian agriculture.[xv] Despite the prevalence of dairy robotics in Ontario today, interviewees note that the acceptance and adoption of the technology has been gradual:

> *It takes time for the stuff to become widely accepted. And especially in North America and Canada, it seems […] if it works in Europe, it doesn't necessarily mean it's going to work here. I don't know. It's weird how that is, right? There was like 10,000 robots milking in Europe before people decided it would be a good idea to have one here* (Ag-Related Tech Company 7).

Leading global dairy robotics companies, including Lely,[xvi] DeLaval,[xvii] and GEA [xviii] are actively involved in selling, servicing, and producing robotic milking systems used by Ontario farmers. More specifically, Lely, founded in the Netherlands in 1948 as a producer of agricultural machinery, launched the first automated robotic milking system on the market in 1992.[xix] Lely

distributes and services its systems in Ontario through a network of six locally owned and operated Lely Centres, located across the province.[xx] DeLaval, founded in 1883 as a dairy separator machine producer in Sweden,[xxi] opened a new technical training centre in 2023 in Peterborough, Ontario. The centre educates and trains DeLaval dealer technicians and staff from across the country so they are knowledgeable about the company's latest milking systems and software.[xxii] GEA, established as farm machinery manufacturer Metallgesellschaft AG in 1881, has evolved into a leading producer and supplier of dairy robotics and dairy technology equipment headquartered in Germany.[xxiii] GEA's dairy robotic systems and other dairy technology solutions are sold and serviced through a network of nine locally owned dealerships in Ontario.[xxiv]

Impacts for Work & Rural Development

Robotic milking technology has reshaped rural agriculture in Canada, especially in dairy-dominant regions like Ontario, introducing efficiency while changing the skills requirements and demand for labour.[xxv,xxvi] As Ag-Related Tech Company 7 explained: *you can fill more kilograms of milking quota with less cows on a robot. So invariably through that, you're milking less cows, you're feeding less cows, you're breeding less cows, you have less manure, you use less acreage, all of that stuff starts to add up and equates to efficiency*.

Addressing Labour Shortages

Agriculture and food operations in Ontario and across Canada continue to face labour shortages. Interviewees described labour shortages as the primary reason for dairy robotics adoption:

> *So I would say currently probably the biggest driver to this technology is labour. Like the labor shortage is a very real thing. It's just hard to find people to do that type of work. So challenges are there and it's become accepted that this technology works, it works well* (Ag-Related Tech Company 7).

By adopting robotic milking technology, farmers reduce their time spent on manual labour in their dairy operations. Interviewees noted how this shift not only improves operational efficiency and productivity but also enhances farmers' quality of life, promoting a more open and flexible lifestyle than previously possible:[xxvii]

> *So when you're cutting hay, for example, in the summer, instead of going into milk at 4 p.m., you can just stay out and do your chores later at night. Or if your kid has a hockey game, you can go watch them. It's the flexibility, the family values that a lot of farms really appreciate, right?* (Ag-Related Tech Company 7).

Interviewees also noted that changing the nature of farm work is making it more attractive to younger people:

We've had farmers tell us that since they've added the technology, the children, the second generation, is that they're kind of certainly more interested in peaked and now this is kind of their style of farming, right? So I think that's another driver is that it's more family-friendly, the flexibility. It's more […] attractive for the future generations to dairy farm than it would be if they were in the older technologies (Agriculture Technology Company 7).

Development of Technical Skills

While robotic milking technologies can reduce the manual labour associated with milking, they also shift work toward more technologically oriented tasks. For example, dairy robotics require maintenance. Regular maintenance by trained service technicians is critical to ensure the ongoing operation of dairy robotics and includes cleaning, software updates, and minor adjustments to improve the performance of dairy robotics systems.[xxviii] This generates a need for skilled technicians with the appropriate technical skills. It also creates a need for training to equip technicians, farmers, and farm workers with the knowledge and skills needed to manage the technology.[xxix,xxx] Interviewees described the technical skill requirement for dairy robotics service and maintenance personnel:

> *[…] we have a bunch of kids that came from, like they had robots at home and come from a farm or grew up on a farm and they're fantastic technicians. You don't need to have a university degree to work with these, but it helps to have technological skills and probably be mechanically inclined. Let's be honest, you're taking stuff apart, right? So that helps* (Ag-Related Tech Company 7).

Training for farmers also facilitates a smooth transition to new automated systems, focusing on system operation, essential maintenance, and troubleshooting to mitigate downtime.[xxxi] Interviewees noted the lower technical skill requirements for farmers using dairy robotics:

From a farmer's perspective, yeah, it's computer software that's designed for farmers. I say that all the time. You don't need a computer engineering degree to navigate the software. It's designed simply enough that farmers can manage it (Ag-Related Tech Company 7).

Animal Health & Welfare

The introduction of dairy robotics can also have a positive impact on animal health and welfare. The design of the technology encourages cows to choose when to be milked. This reduces stress in the animals and leads to more frequent milking sessions, which boosts milk production.[xxxii,xxxiii] Real-time monitoring capabilities via computer vision and sensors also improves animal welfare through the earlier detection of animal health problems. Additionally, these systems provide farmers with data to enhance their decision-making related to animal health and farm management.[xxxiv] One interviewee further described the animal health and welfare benefits of dairy robotics:

So cows will live longer. So yeah, you're replacing less cows. It's healthier for cows, they get milked more often. Yeah, definitely, there's absolutely benefits to the cow as well, for sure. They're under less stress. When you're in a holding pen being pushed into a parlor, there's much more stress there. So you can even notice it when you go into a robotic barn that the cows are quiet and cows are much more calm, subdued. They're almost pets in some ways. They'll come up to you and start licking your coat and say, get away. But in a parlor environment, when you walk in the barn, they scatter, because every time you go into the barn, they typically think, hey, they're coming in to get me. So it's much more cow friendly for sure as well (Ag-Related Tech Company 7).

Environmental Benefits

Dairy robotics systems can also reduce resource consumption, decrease waste, and enhance sustainability on farms.[xxxv,xxxvi] As one interviewee described, there can be environment benefits because the collectors run on batteries and therefore use less electricity. They further noted that "[…] *especially the Lely robot, for example, like you talk to nutrient management planners and they can use a smaller manure pit due to the fact that [it uses] less resources"* (Ag-Related Tech Company 7).

Retrofits & Infrastructure Costs

Although farmers anticipate that automation will increase revenues from milk production, it takes time. The adoption of dairy robotics systems may require a transition period of up to four years to achieve profitability.[xxxvii] Moreover, the upfront capital costs associated with barn retrofits, building new facilities, and infrastructure upgrades can be barriers to adoption. Implementing robotic milking technology often requires upgrading farm electricity systems and internet connectivity.[xxxviii] The need for internet and electricity reflects the modern dairy industry's shift towards data-driven decision-making on farms. Interviewees commented on the retrofit and infrastructure costs associated with dairy robotics:

I would say the biggest challenge is adopting these technologies in Ontario, especially in Ontario and Quebec, I would say, would be a lot of the dairy farms, not a lot, but a good chunk of them still are tie stalls, […], a tie stall is a smaller footprint and that takes a bit more of a work to retrofit a robot in or would require a whole new barn altogether. So that would be a bit more of a challenge. If you have a tie stall farm with 40 cows, it's a little bit more challenging to adopt this technology than it would be, say, you have a free stall in a parlor already. It's much easier to retrofit (Ag-Related Tech Company 7).

However, Ag Industry Expert 2 explained how this can also benefit the wider regional economy:

So the barn builders, the engineers, the designers, all of the various pieces that go along with bringing that in. Because […] I can't think of a scenario where you just have a barn that's ready to go and you plunk the robotic milker in. It's usually incorporated in an

entirely new build or certainly a significant renovation. So there's a whole piece that comes along supporting that.

Future Opportunities

While supportive policies, including agricultural grants and subsidies, promote the development and adoption of dairy robotics,[xxxix] initial investment costs remain a substantial barrier. Financial incentives, such as agricultural grants and low-interest loans, enable farmers to adopt advanced technology by reducing economic barriers. These incentives make it financially viable for farmers to invest in and train on technologies.[xl] Similarly, funding for training programs are crucial for bridging the gap between the adoption of technology and its practical application on the farm, ensuring investments in dairy robotics lead to improvements in productivity, animal welfare, and farm profitability.

References

[i] Matson, R. D., King, M. T. M., Duffield, T. F., Santschi, D. E., Orsel, K., Pajor, E. A., Penner, G. B., Mutsvangwa, T., & DeVries, T. J. (2021). Benchmarking of farms with automated milking systems in Canada and associations with milk production and quality. *Journal of Dairy Science, 104*(7), 7971–7983. https://doi.org/10.3168/jds.2020-20065mison

[ii] Monov, V., & Karastoyanov, D. (2021). Innovations in robotic cow milking systems. *20th International Conference on Advanced Robotics (ICAR)*, 58–63. https://doi.org/10.1109/ICAR53236.2021.9659447

[iii] Eastwood, C. R., Dela Rue, B., Edwards, J. P., & Jago, J. (2022). Responsible robotics design–A systems approach to developing design guides for robotics in pasture-grazed dairy farming. *Frontiers in Robotics and AI, 9,* 914850.

[iv] Monov, V., & Karastoyanov, D. (2021). Innovations in robotic cow milking systems. *20th International Conference on Advanced Robotics (ICAR)*, 58–63. https://doi.org/10.1109/ICAR53236.2021.9659447

[v] Monov, V., & Karastoyanov, D. (2021). Innovations in robotic cow milking systems. *20th International Conference on Advanced Robotics (ICAR)*, 58–63. https://doi.org/10.1109/ICAR53236.2021.9659447

[vi] Lely. (2023). History. https://www.lely.com/ca/en/about-lely/our-company/history/

[vii] Driessen, C., & Heutinck, L. F. M. (2015). Cows desiring to be milked? Milking robots and the co-evolution of ethics and technology on Dutch dairy farms. *Agriculture and Human Values, 32*(1), 3–20. https://doi.org/10.1007/s10460-014-9515-5

[viii] Driessen, C., & Heutinck, L. F. M. (2015). Cows desiring to be milked? Milking robots and the co-evolution of ethics and technology on Dutch dairy farms. *Agriculture and Human Values, 32*(1), 3–20. https://doi.org/10.1007/s10460-014-9515-5

[ix] Matson, R. D., King, M. T. M., Duffield, T. F., Santschi, D. E., Orsel, K., Pajor, E. A., Penner, G. B., Mutsvangwa, T., & DeVries, T. J. (2021). Benchmarking of farms with automated milking systems in Canada and associations with milk production and quality. *Journal of Dairy Science, 104*(7), 7971–7983. https://doi.org/10.3168/jds.2020-20065mison

[x] BouMatic. (2023). Gemini UP | Exclusive Design—Better Results. *BouMatic.* https://boumatic.com/products/gemini-up-2/

[xi] Dairy Farmers of Ontario. (2024). *Committed to Quality and Tradition*. https://new.milk.org/About-Us

[xii] Dairy Farmers of Ontario. (2024). *Committed to Quality and Tradition*. https://new.milk.org/About-Us

[xiii] Ontario Ministry of Food, Agriculture and Rural Affairs. (2022). *Ontario business, agri-food, and farm data profiles—South—Niagara* [Data set]. https://data.ontario.ca/dataset/0d8ec71d-373c-47bf-8bfe-254155797a17/resource/fbacfb13-faae-4474-a8f6-b11c06b2de52/download/niagara.xlsx

[xiv] Ontario Ministry of Food, Agriculture and Rural Affairs. (2022). *Ontario business, agri-food, and farm data profiles—South—Niagara* [Data set]. https://data.ontario.ca/dataset/0d8ec71d-373c-47bf-8bfe-254155797a17/resource/fbacfb13-faae-4474-a8f6-b11c06b2de52/download/niagara.xlsx

[xv] Ivus., M., Matthews, M., Snider., N., Taillon, P., Watson, M. (2021). Canadian Agri-food Technology: Sowing the Seeds for Tomorrow" September 2021. *Information and Communications Technology Council (ICTC)*. Ottawa, Canada.

[xvi] Lely. (2023). History. https://www.lely.com/ca/en/about-lely/our-company/history/

[xvii] DeLaval. (n.d.). Milking. Retrieved October 16, 2023, from https://www.delaval.com/en-ca/explore/milking/

[xviii] GEA Group Aktiengesellschaft. (n.d.-b). Robotic Milking Systems for any herd size. Retrieved October 15, 2023, from https://www.gea.com/en/products/milking-farming-barn/dairyrobot-automated-milking/index.jsp

[xix] Lely. (2023). History. https://www.lely.com/ca/en/about-lely/our-company/history/

[xx] Lely. (2024). Find your own local Lely Centre. https://www.lely.com/ca/en/locator/

[xxi] GEA Group Aktiengesellschaft. (n.d.-b). Robotic Milking Systems for any herd size. Retrieved October 15, 2023, from https://www.gea.com/en/products/milking-farming-barn/dairyrobot-automated-milking/index.jsp

[xxii] DeLaval. (2023). *DeLaval invests in Canadian dairy community with new training center in Ontario.* https://www.delaval.com/en-us/learn/newsroom/delaval-invests-in-canadian-dairy-community-with-new-training-center-in-ontario/

[xxiii] Agriculture and Agri-Food Canada. (2021). Automatic milking system guidelines. https://agriculture.canada.ca/en/sector/animal-industry/canadian-dairy-information-centre/acts-regulations-codes-and-standards/automatic-milking-system-guidelines

[xxiv] GEA. (2024). *Dairy Farming Dealers.* https://www.gea.com/en/dealer-finder/

[xxv] Ontario Ministry of Food, Agriculture and Rural Affairs. (2022). *Ontario business, agri-food, and farm data profiles—South—Niagara* [Data set]. https://data.ontario.ca/dataset/0d8ec71d-373c-47bf-8bfe-254155797a17/resource/fbacfb13-faae-4474-a8f6-b11c06b2de52/download/niagara.xlsx

[xxvi] Ontario Ministry of Food, Agriculture and Rural Affairs. (2022). *Ontario business, agri-food, and farm data profiles—South—Niagara* [Data set]. https://data.ontario.ca/dataset/0d8ec71d-373c-47bf-8bfe-254155797a17/resource/fbacfb13-faae-4474-a8f6-b11c06b2de52/download/niagara.xlsx

[xxvii] Cunnane, C. (2021, June 28). Robotic Milking Systems: A guide for farmers before investing. Thatsfarming.Com. https://thatsfarming.com/dairy/robotic-milking-systems/

[xxviii] Salfer, J., Endres, M., Lazarus, W., Minegishi, K., & Berning, B. (2019, August 16). Dairy Robotic Milking Systems – What are the Economics? *DAIReXNET.* https://dairy-cattle.extension.org/dairy-robotic-milking-systems-what-are-the-economics/

[xxix] Hansen, B. G., Herje, H. O., & Höva, J. (2019). Profitability on dairy farms with automatic milking systems compared to farms with conventional milking systems. *International Food and Agribusiness Management Review, 22*(2), 215–228. https://doi.org/10.22434/IFAMR2018.0028

[xxx] Hansen, B. G., Herje, H. O., & Höva, J. (2019). Profitability on dairy farms with automatic milking systems compared to farms with conventional milking systems. International Food and Agribusiness Management Review, 22(2), 215–228. https://doi.org/10.22434/IFAMR2018.0028

[xxxi] Salfer, J., & Endres, M. (2020, November 30). Keys to success with Robotic Milking Systems. *Dairy Herd Management - Farm Journal, Inc.* https://www.dairyherd.com/news/dairy-production/keys-success-robotic-milking-systems

[xxxii] Matson, R. D., King, M. T. M., Duffield, T. F., Santschi, D. E., Orsel, K., Pajor, E. A., Penner, G. B., Mutsvangwa, T., & DeVries, T. J. (2021). Benchmarking of farms with automated milking systems in Canada and associations with milk production and quality. *Journal of Dairy Science, 104*(7), 7971–7983. https://doi.org/10.3168/jds.2020-20065mison

[xxxiii] Monov, V., & Karastoyanov, D. (2021). Innovations in robotic cow milking systems. *20th International Conference on Advanced Robotics (ICAR)*, 58–63. https://doi.org/10.1109/ICAR53236.2021.9659447

[xxxiv] Jelinski, M. D., Kelton, D. F., Luby, C., & Waldner, C. (2020). Factors associated with the adoption of technologies by the Canadian dairy industry. *The Canadian Veterinary Journal, 61*(10), 1065–1072.

[xxxv] Cogato, A., Brščić, M., Guo, H., Marinello, F., & Pezzuolo, A. (2021). Challenges and tendencies of automatic milking systems (AMS): A 20-years systematic review of literature and patents. *Animals, 11*(365), 1–21. https://doi.org/10.3390/ani11020356

[xxxvi] King, M. T. M., Matson, R. D., & DeVries, T. J. (2021). Connecting farmer mental health with cow health and welfare on dairy farms using robotic milking systems. *Animal Welfare, 30*(1), 25–38. https://doi.org/10.7120/09627286.30.1.025

[xxxvii] Hansen, B. G., Herje, H. O., & Höva, J. (2019). Profitability on dairy farms with automatic milking systems compared to farms with conventional milking systems. *International Food and Agribusiness Management Review, 22*(2), 215–228. https://doi.org/10.22434/IFAMR2018.0028

[xxxviii] Rotz, S., Duncan, E., Small, M., Botschner, J., Dara, R., Mosby, I., Reed, M., & Fraser, E. D. G. (2019b). The Politics of digital agricultural technologies: A preliminary review. *Sociologia Ruralis, 59*(2), 203–229. https://doi.org/10.1111/soru.12233

[xxxix] Cogato, A., Brščić, M., Guo, H., Marinello, F., & Pezzuolo, A. (2021). Challenges and tendencies of automatic milking systems (AMS): A 20-years systematic review of literature and patents. *Animals, 11*(365), 1–21. https://doi.org/10.3390/ani11020356

[xl] Holloway, L., Bear, C., & Wilkinson, K. (2014). Re-capturing bovine life: Robot–cow relationships, freedom and control in dairy farming. *Journal of Rural Studies, 33*, 131–140. https://doi.org/10.1016/j.jrurstud.2013.01.006