Robotics in Agriculture

When you picture a dairy farm located in a rural community, you may imagine a farmer walking to the barn in his coveralls before sunrise. The farmer is ready to milk his herd of 50 cattle, feed them and then spend the majority of his day cleaning the barn and tending to other chores, only in preparation to milk them once again. This is hardly the case at a growing number of farms across Ontario. Many are becoming increasingly automated allowing farmers to spend more time focusing on the management of their herds.

One milking robot can milk 60 cows 24 hours a day, 7 days a week. A robot can push feed up in front of the cattle every two hours, while an automatic barn cleaner guarantees a clean barn as well as cow comfort. Brushes make sure that the cows are well brushed and comfortable, and an automated lighting system contributes to the cows' well being through a kind of light therapy. [i]

It seems as though robots are taking over the agriculture industry, but this increase in automation is actually increasing food production. Robotic machines are more

efficient than humans and they are available to work 24 hours a day, 7 days a week. Thus, the technology of robotics is contributing to a more productive farming operation. In the future, fully automated farms will become more common throughout the world due to the many advantages compared to traditional farming methods.

Interesting Facts [xii]

Owners of robotic milking systems ranked their reasons for choosing automated milking systems:

1. avoiding frustrations of dealing with hired labour;
2. opportunity for more frequent milking;
3. flexibility and lifestyle advantages of not being tied to a fixed milking schedule;
4. the desire to be innovative.

Ontario has over 75 dairy farms with automated milking system experience.

The first commercial robotic milking system on this continent was installed in Ontario, Canada in March 1999.

Advantages of Robotics in Agriculture

Many farms are becoming ever more dependent on robotic machines in their daily routines. Farmers, especially in the dairy industry, are having trouble finding workers that are willing to do the hard manual labour that is required to run a successful farm. For example, some people may not want to milk cows twice a day, 7 days a week, for a small salary. Robotic machines on the other hand, are available to work all day, every day and will save the farmer from today's high cost of labour.

Robotic machines are also well suited to perform repetitive work. The consistency of performance is reliable, which can help to improve quality in a number of areas. They can also ensure healthier livestock by providing feed several times a day, compared to just once a day, which has been shown to increase milk production in dairy cows. They also allow the farmer to refocus their time. When producers do not have to spend most of their day performing manual labour, they can focus on other tasks that are important to the growth and sustainability of their business.

Yet, the picture is not perfect. The cost associated with starting up a robotic farming operation, or switching over from conventional farming is significant. When the amount of savings in labour costs is considered though, the producer will be able to recoup those investments easily. Incorporating robotics will most likely pay off in the end because the farmer will save on labour costs, and may have a system which results in more productivity, thus higher profit margins. As well, when the work is less intensive, the farmer may be able to work later into life than was possible before.

A farm family from Ontario made the switch to robotic milking, and found that the machine paid for itself more quickly than they had anticipated. Dirk was suffering from health problems that would have forced him from the industry. He was able to continue farming and they were also able to replace an employee. "It was an investment in our health," he said. [ii]

Types of Robotics

Robotic Feeders [viii ix]

In addition to tending to animals and cleaning the barns, robots have also taken over the job of feeding the livestock. Manually feeding an entire livestock farm is a very labour intensive process, taking large amounts of time to complete the task. Therefore, many modern farms have adopted a new technique using a feeding robot that automatically feeds livestock according to settings predetermined by the farmer. Feeding robots are mainly built on rail systems and can easily move throughout the barn to deliver the correct feed to each animal without disturbing them.

Using a robotic machine to perform this activity is much more time efficient and can lead to better health and production of the livestock. Feeding can be done multiple times a day, which has been shown to increase milk production in dairy cattle. Farmers are able to prescribe individual recipes for each animal, ensuring that it gets the appropriate amount of food and nutrients specific to its life stage. The robot also prepares specific feed for young livestock and continues with optimum feeding for each stage of growth, leading to a healthier animal. An automated feeding system also increases general cleanliness and hygiene in the barn. Programming the correct amount of feed for each animal ensures that the previous feed has been eaten before fresh feed is delivered. This keeps feed quality high and reduces the need to remove old feed manually.

Robotic Alley Scrapers [vi vii]

With an automated milking system, the dairy barn becomes designed with alleys (walking paths), to direct cow movement to the milking parlor and other areas. These high traffic paths become littered with manure throughout the day. It is important to keep these dairy barns clean in order to reduce the risk of cows

dragging manure into their stalls, which may ontaminate stall beds and eventually lead to poor udder health. Manually cleaning these alleys is a very labour intensive and time consuming task. The use of an automated alley scraper eliminates the use of manual labour to complete this chore.

A robotic alley scraper is a robot that moves throughout the alleys of the barn without assistance, clearing manure while following its programmed path. They can be programmed to more frequently scrape the areas in the barn where manure builds up faster than other areas of the barn. Robotic alley scrapers are non-intrusive and do their job quietly, having little effect on cow behaviour. If they encounter a cow lying in the alley, some models will either try to go around it or try several times to push it out of the way. If the cow will not move, the robotic scraper will shut down and wait for the farmer to take action. With many models able to clean between 6,000 and 8,600 square metres of barn surface up to 8 times a day, the need for manual labourers on a dairy farm is significantly decreasing.

Milking Robots [iii iv]

The milking robotic system is designed to reduce physical labour required by humans. Many dairy farmers are finding it hard to find workers that are willing to milk twice day, seven days a week. An automated milking system allows the cows to be milked 24 hours a day, improving efficiency of the operation. It allows cows to choose how often they are milked each day, acting as a more natural and stress free way

Continued

of milking. When a farmer milks cows manually, they are restricted to do so only two or three times daily. However, if using an automated milking system, cows may be milked more if they prefer, increasing milk production and reducing stress on the animal.

When the cow is ready to be milked, it walks up to the machine at its own will, enticed by feed. A milking robot identifies the cow, usually by an electronic tag, and determines if the cow is to be milked. The robot will release the cow if the computer detects that it has already been milked enough or needs special treatment. Once it has been approved for milking, the computer feeds the cow according to its feeding requirements, programmed by the farmer, to keep the cow content. The robot then begins the milking process, locating the teats, cleaning the udder, and attaching the milking cups. When milking is completed, the milk is measured, inspected for impurities and pumped away. All milking information is then saved in the robot's computer system.

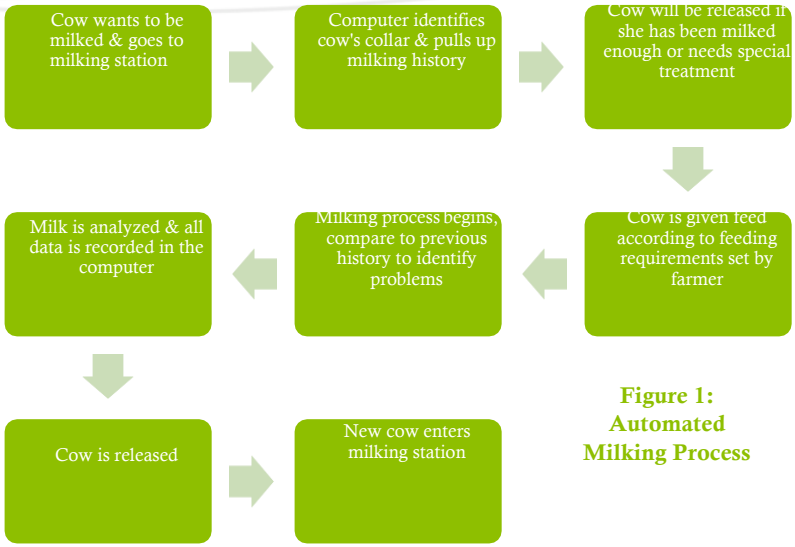

Figure 1: Automated Milking Process

Robotic Feed Pushers [xi]

Many dairy farmers will tell you that ensuring feed is constantly available for their cattle means an increase in milk production. On many farms, skid steers are used to push feed up to the bunk. Skid steers perform many jobs on that farm and will occasionally have manure on the tires. This manure can then end up in the feeding area and can prove to be a big biosecurity issue. The average farm will push feed in front of their cattle 4 times a day, taking between 5 and 10 minutes to complete the job.

To help alleviate biosecurity and labour issues on dairy farms, robotic feed pushers have been developed to automatically travel down the feeding alley. They push feed towards the bunk as often as required without disturbing the cows. Manufacturers of robotic feed pushers claim that this robot contributes to the welfare of cattle by stimulating the cows to approach the feed bunk more often and allows all animals in the barn to have sufficient access to fresh feed. According to Jack Rodenburg of DairyLogix, there are no reliable numbers on what increase in feed intake a farmer can expect when feed is pushed up more often. However, most nutritionists would predict higher feed intake from more meals per day, and that should increase milk production, decrease feed production costs per litre of milk produced, and decrease the incidence of rumen acidosis and associated health problems.

The feed pusher has the potential to save farmers valuable time by providing them with the flexibility and freedom to devote their energy to other tasks. Like any major farm purchase the decision as to whether or not the technology will payoff will be highly variable from farm to farm. It is dependent on the cost, time required and relative costs and benefits of doing the job another way. Many farmers who have this technology on their farm feel the benefits outweigh the costs, especially in terms of labour savings.

Careers in Robotics

The use of robotics is becoming more prevalent in all stages of the agricultural process. As a result of this range of uses and implementation, there is also a variety of career opportunities in the field of robotics. Essentially, there are jobs available at the stages of Research and Development (R&D), product sales and service, and product training and implementation.

Careers in R & D are as diverse as the types of robotics in use. Jobs in this area may range from a very academic and science-based position where you are engineering the robotic instruments, to testing the application of the robots in a lab, or farm environment. Science and inquiry skills are necessary in these positions. Researchers also need to have the ability to problem solve in order to develop new and innovative products that will work effectively for producers around the world.

There is also a need for individuals who are familiar with the robotic equipment when it reaches the market. To be a product specialist or marketing person, you will need to have an understanding of the technology behind the robotics. Marketing individuals will possess the ability to communicate clearly and to help people decide which products will work best for them and their unique situations.

Positions in the service industry require excellent tactile, or hands on ability, to address issues with the complex equipment, in addition to the skill of analyzing the system to determine the problem. Companies that develop robotic equipment also hire trainers to teach other individuals how to set up, use, and maintain the equipment in the most effective way. As with any training position, the relevant skills include a mastery of industry knowledge and the ability to clearly communicate to a variety of individuals. These positions are extremely important as they help the producers to properly utilize machinery which costs them (most often) large amounts of money.

As the field of robotics continues to grow, so will the opportunities in the sector. For more examples of occupations in agricultural robotics, check out the career pages of companies such as Lely (www.lely.com) and DeLaval (www.delaval.ca).

Interview

Elizabeth Healy
Marketing and Communications Coordinator
DeLaval Inc.

Please describe a typical day at your job:

- Variety
- Challenges
- Interest
- Growth
- Education

My day could involve creative production of advertisements, trade show visuals, brochures, flyers, on-location photo shoots, interviews, web editing, media tours, press release coordination, conference calls, meetings with suppliers, project management, corporate events and public relations. There is also daily interaction and liaising with colleagues from across North America and Europe via conference calls, on-site meetings.

How did you become interested and get involved in your position?
Excellent question. Firstly, I truly enjoy working with people. If I can contribute towards something positive I derive great satisfaction. I take great pride in cascading our DeLaval message, our brand, its mission, vision and values internally and externally.

I was fortunate to be recruited by a company who values and embraces my bilingual abilities, creative talents, organizational capacities while also permitting me the opportunity and latitude to continue to grow, challenge and develop myself.

I applied for the position in advertising. I believed my public relations; marketing and communications experiences would be advantageous in the position.

What do you like best about your job?
There are many aspects of my job I find appealing. There is incredible variety, travel, project management and enormous responsibility associated with my position. I believe in preserving brand equity, continued research and development to deliver innovation, that we are caretakers of the environment and wellbeing of farm animals. I am proud to be associated with DeLaval. I admire the innovation and dedication to supporting the dairy industry. I am humbled by our customers' commitment to providing nature's purest food, milk.

What does it take to be successful in your position?
To be successful you need a genuine willingness and capacity to work with people You need to be resources, patient and be interested in continually developing.

You need to be a team player, have computer proficiency skills, knowledge of current printing practices, project management skills, bilingual, and a high energy level.

What suggestions would you give to students interested in pursuing a similar career path?
I would encourage them to consider post-secondary education in the field of journalism, marketing and business. I would also suggest learning a second or third language would be beneficial.

Where do you see the agricultural robotics industry heading in the future?
The challenges facing today's dairy farmer are tough. Milk prices fluctuate; labour and energy costs keep rising. The economic future is already now being defined by scale and efficiency. Larger-scale dairy farms will be the response in order to successfully meet the challenges. Innovative integrated solutions designed to accelerate your transition from milking management to total farm management.

It will be about profitability and growing a sustainable business not just about how many cows you milk, but how you milk them. Companies like DeLaval will help dairy farmers grow profitably by working smarter to drive greater efficiency, productivity and business by integrating products, services and knowledge for better quality milk, herd management, productivity and profit.

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Robotics in Agriculture Teacher's Guide

The curriculum expectations outlined in this document are intended as an overview of potential connections between Robotics in Agriculture and learning in the classroom. This is by no means an exhaustive list, and we acknowledge that there are several subjects outside of science, which can be touched upon when teaching about Robotics in Agriculture. However, we hope that this list will inspire you to think about how science and agriculture fit together, in ways that you may not have thought about before. We encourage you, the educator, to extend the activities based on your preference and the learning needs of your students.

Curriculum Links

Science All Strands
Scientific Investigation Skills and Career Exploration
A2. identify and describe careers related to the fields of science under study, and describe the contributions of scientists, including Canadians, to those fields.

Biology
SBI4U
Population Dynamics
F1. analyse the relationships between population growth, personal consumption, technological development, and our ecological footprint, and assess the effectiveness of some Canadian initiatives intended to assist expanding populations.

Environmental Science
SVN3M
Sustainable Agriculture and Forestry
D1. evaluate the impact of agricultural and forestry practices on human health, the economy, and the environment.

Technology
Green Industries
THJ3M THJ3E THJ4M THJ4E
Green Industry Fundamentals
A2. demonstrate an understanding of the effects of biotic and abiotic factors on growth and product quality.
A3. develop and evaluate designs or processes for a variety of applications related to the green industries.
A4. use mathematical, documentation, research, and communication skills as they apply to the green industries.

Green Industry Skills
B1. demonstrate an understanding of and apply design and production practices that are commonly used in the green industries.
B2. apply management strategies for assessing and controlling biotic and abiotic factors that affect plant and/or animal quality.
B3. demonstrate competence in technical skills related to specific applications and tasks within the green industries.

Technology, The Environment and Society
C1. analyse the impact of the green industries on the environment and describe ways of minimizing harmful effects.
C2. analyse social and economic relationships and issues involving the green industries.

Professional Practice and Career Opportunities
D1. demonstrate an understanding of and apply safe working practices as they relate to the green industries.
D2. demonstrate an understanding of the business and regulatory environment of the green industries.
D3. identify careers in the green industries, and describe the skills, education, and training required for entry into these occupations.

Suggested Activities

1. **Assessing Robotics in Agriculture:** ***What role will robotics play in the future of agriculture?***
   - Students research the use of robotics in agriculture in Canada, and around the world.
   - Topics of interest may be, farm labour, the environment, economic and social implications in developing countries.
   - Hold a class debate on the topic of robotics in agriculture or have students write an article discussing their function in feeding a growing population.

2. **Tools and Technology*: Assessing the Impact of Robotics in Agriculture on workers in the industry***
   - Students evaluate the impact of robotic technology on the lives of producers, farm workers, farm managers, equipment sales/service people.
   - Sources may include articles in farm publications, interviews, journal articles.
   - Students will prepare an opinion piece, or develop a presentation to share their findings with the class from the perspective of one of those groups on the use of robotics.

3. **Working with Robots:** ***What are the options?***
   - Students will research the career opportunities in the areas related to robotics in agriculture: engineering, marketing, servicing, farming with them, etc.
   - Contact an individual in one of these positions and interview them about their job.
   - Create a video or radio presentation, which highlight the chosen career.

4. **Tomorrow's Robotics:** ***What will the future hold?***
   - Discuss with students what they have read or heard about robots helping to improve the quality of life for farmers.
   - Students select a type of production agriculture and design a robot that will help the people who work in that industry do their job.
   - Students should draw and label their robot and write a paragraph about how their invention could have a positive impact on the quality of life for a farmer. Ask each student to end his or her paragraph by predicting whether the robot will be accepted by the industry and society.

5. **Case Study:** ***Embracing Technology***
   - Students choose one of the following situations to address in a paper or oral presentation:

Activity 1: Your grandfather and uncle, who run a 150 head dairy operation in Ontario, are continually arguing about whether or not to incorporate various technologies into their work. Your grandfather generally believes that technology is destroying the farming industry, while your uncle thinks that embracing technology is the only way that their farm will survive and prosper. They want you to give an impartial view of the positive and negative impacts of various technologies (e.g., milking robots, robotic alley scrapers, etc.) so that they can make informed decisions.

OR

Activity 2: In your recent travels you came across a remote farming community that has been cut off from the rest of the world for generations. You are a farmer from Ontario who has been incorporating various advanced and emerging technologies into your work. Based on your understanding of the positive and negative impacts of these technologies, what types of technology would you choose to introduce to this remote community? On what did you base your decision?

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