



Research Reports

Technology in the Dairy Industry: Historical and Future Perspectives

Technology is everywhere on modern dairy farms. It is now common to see cows being milked using machines like automated milking systems and wearing electronic sensors such as activity monitors that can be used to help detect when cows are in heat. In addition to these examples, there are numerous other tasks on dairy farms that can be done using robotics, electronics and a host of other technologies. Some of these technologies are now very familiar like artificial insemination and embryo transfer, whereas newer ones like sexed semen are rapidly gaining traction.

Recently, the use of genetic engineering tools like CRISPR (clustered regularly interspaced short palindromic repeats) have enabled geneticists to change cattle DNA by adding or removing genes. This technology is often referred to as gene editing. Gene editing applications in development include removing the horn producing gene so cattle do not grow horns, adding a shorter hair coat gene so cattle are more heat tolerant, and changing genes so animals are more resistant to infectious diseases.

To better understand how dairy farms are likely to respond to the development of these new genetic technologies, we can look to the past to see how the industry has responded to the introduction of other technologies and also engage in conversations with dairy farmers.

Three recent projects at UBC investigated the changing role of technology on dairy farms. The first of these reviewed the history of technology use, with a special focus on breeding technologies. The second illustrated one component of this history, using an interactive online “Storymap” to illustrate how the Holstein-Friesian breed became common worldwide. Finally, we interviewed Western Canadian dairy farmers about their views on technology adoption over time, including the emerging technology of gene editing.

Our historical review illustrated how the aims of cattle breeding have changed over time. In the centuries before and up to the 1700s, animals were selected for multiple purposes, including food and labour, and people believed that the physical environment played a large role in determining animal traits. This explains place names given to animals, for example the Dutch province of Friesland produced the Friesian breed. In the mid 1800s, American merchants began importing this breed given its focus on higher milk production. This represented a change in breeding practices, from selecting multi-purpose animals to selecting for a specialized production trait.

In the early 1900s, artificial insemination was developed, and milking data began being collected by breed associations enabling the evaluation of heredity through statistics. In 1952, scientists invented a freezing technique for semen, increasing its potential to be transported and stored (Fig 1). These technologies faced resistance, however, as they



shifted breeding practices. In earlier times, breeders would select and sell stock to farmers. Artificial insemination meant that scientists were now heavily involved in trait selection, and laboratories rather than farms became the physical spaces for selecting desired traits.

Today, breeding continues to be mediated by technology and technologies like gene editing may further enable the selection and change of specific, individual genes. When we spoke with Western Canadian dairy farmers about technology, we found that they were familiar with genomic testing and discussed herd genetics, but gene editing was not well known. Whilst some saw gene editing as improving genetics, with one farmer expressing that gene editing is “the natural next step” in advancing breeding technology, others were unsure.

Farmers that were unsure of the role of gene editing felt that they had already solved the issue at hand. For example, considering the hornless gene editing application, one farmer mentioned that they already sedate and use pain mitigation when dehorning calves, and consider this an adequate solution. Finally, in the quote below, one farmer summarized their support for straightforward applications but was concerned about potential unknown consequences of the technology.

“If you're [going to] start gene editing, polled, I think is an easy one, you just have something out. You can take a little snip out, so there's no more horns ... But I have some concerns. And I would probably, for a lot of other technology, I don't mind being the first in, but with gene editing, I'm way more skeptical. I just think you're trying to make a puzzle but you don't even know what all the pieces are.”

In summary, breeding technologies have evolved over time, with humans initially selecting for multi-purpose animals, then specialized traits like milk production. Today, gene editing is an emerging technology that can change DNA through the addition or deletion of specific traits and genes from animals. Western Canadian dairy farmers were less familiar with gene editing, however they saw how the technology fit with existing tools, and recognized potential benefits and risks of the technology.

Photos:

Figure 1: Photo from a 1970s advertisement from the British Oxygen Company celebrating artificial insemination.





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