BRINGING ANIMAL WELFARE AND ARTIFICIAL INTELLIGENCE TOGETHER

Detecting changes in behavior can signal health insights.

by Célia Julliot and Awa Samaké

IN RECENT years, the dairy industry has seen rapid growth in digital tools, sensors, and automated systems. Yet one question remains central: How can these technologies genuinely support animal welfare while keeping farms efficient and sustainable? The WELL-E Research and Innovation (R+I) Chair was created to tackle this challenge. Founded in 2022 by Abdoulaye Baniré Diallo at the Université du Québec à Montréal (UQAM) and Elsa Vasseur at McGill University, it is the first initiative of its kind dedicated to combining animal welfare science and artificial intelligence (AI).

The chair works with more than 30 partners from industry and academia across Canada, uniting researchers, farmers, and industry specialists around a shared mission: to develop tools that respond directly to the needs of farmers and industry stakeholders, while training a new generation of specialists fluent in both fields.

WELL-E R+I Chair is structured around four main research themes, each addressing a key challenge of the dairy sector. For example, imagine cameras installed on the farm detecting lameness before it becomes too serious, or your milking robots alerting you to a case of mastitis. That's what the chair is also conducting research on. Other topics are being studied, such as the detection and tracking of cows using computer vision, the estimation of genetic effects on dairy production, and behavioral analysis, including how environmental factors such as social, physical, nutritional, sensory, and cognitive influence the expression of these behaviors and cattle welfare.

Precision genetics

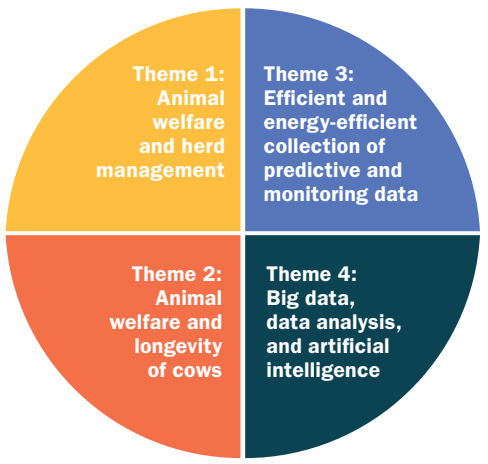
A clear example of this interdisciplinary work is the computer science Ph.D. project of Awa Samaké. She studies how AI can improve the way farmers and advisers evaluate the genetic potential of dairy cows. Instead of relying only on traditional pedigree-based calculations, her work adds computer tools that learn from large amounts of farm data, such as the cow's age, breed, milk records, and health information. These tools can pick up subtle combinations of factors that are hard to see with usual methods. Samaké's models are developed using real data and DNA information from the Canadian DHI Agency (Lactanet).

The aim is simple: make predictions of a cow's future performance or health risks more precisely. For farmers, this could mean more reliably identifying which heifers are worth keeping, which animals are more likely to remain healthy, or which breeding choices could strengthen the herd in the long term. In other words, AI does not replace current genetic evaluations, it sharpens them, offering clearer and more actionable information on which animals will thrive in the barn.

Real-world data

Another key strength of the WELL-E R+I Chair is its "living-lab" approach. Instead of keeping research confined to computer models or controlled laboratory rooms, every tool is tested under real farm conditions. Two main partner farms play a central role in this work: At McGill University's Macdonald Campus Farm in Quebec, cows are kept in a tie stall system. Meanwhile, the Vocational Training Dairy Facility at Joyceville Institution in Ontario uses bedded-pack loose housing. These two contrasting environments give researchers a chance to see how cows behave and move in different housing systems, how they use the space available to them, and how well new technologies perform in each context. This hands-on approach provides direct feedback from the field and ensures that the tools developed are robust, adaptable, and ready to work in the wide variety of barn designs found across the dairy sector.

Figure 1. Main research topics of the WELL-E Chair



What makes the WELL-E R+I Chair stand out is the way its two laboratories work together like two sides of the same coin. On one side, animal behavior specialists spend time watching cows up close, how they get along, how they react to changes in their surroundings, and which small behaviors signal comfort, stress, or a shift in routine. These observations give an extremely detailed view of herd life, but they take time and are hard to carry out continuously in large barns.

On the other side, the bioinformatics and AI team turns barn data into practical tools. They build systems that can process thousands of movement records, videos, sound cues, temperature readings, or signals from accelerometers and global positioning system (GPS) tags. These models can spot tiny changes that people might miss and track long-term trends across the whole herd. With methods like machine learning and computer vision, raw data becomes clear indicators that can support day-to-day decisions, whether it's identifying cows whose behavior is changing, adjusting grouping strategies, or improving comfort and productivity at the herd level.

When these two perspectives work together, they reinforce one another. Behavioral science provides essential context: it defines what should be measured, why it matters, and how to interpret patterns in a biologically accurate way. AI then extends the reach of behavioral research by enabling continuous, automated monitoring of entire herds, day and night, with a level of precision that humans cannot achieve alone.

This synergy is well illustrated in the doctoral work of Célia Julliot looking at behavior and welfare. Her research focuses on the link between social behavior and personality, characterizing individuality in cattle. She studies how cows form social bonds, why some animals consistently behave in certain ways, and how each individual differs in the way it interacts with others. To analyze these patterns, she uses tools such as automated tracking and long-term behavioral datasets that show how relationships and habits evolve over time.

Although her work uses advanced analytical methods, these results are always checked against real observations to ensure that the detected patterns truly reflect meaningful aspects of cow behavior. These insights have direct implications on the farm. Social relationships influence how cows move through shared spaces, how much competition they face at the feedbunk, how stable groups remain during regroupings, and how early changes in behavior can signal that an animal is unwell or stressed. By understanding these dynamics more precisely, her work helps make herd management more predictable and responsive. This constant back-and-forth between behavioral and bioinformatic expertise demonstrates how integrated approaches can produce insights that are both accurate and practically useful.

The combination of these two disciplines offers a more complete and objective understanding of animal welfare. Behavioral observations help calibrate and validate AI tools. In turn, AI systems

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Figure 2. Schematic representation of the R+I Chair Living Lab's approach

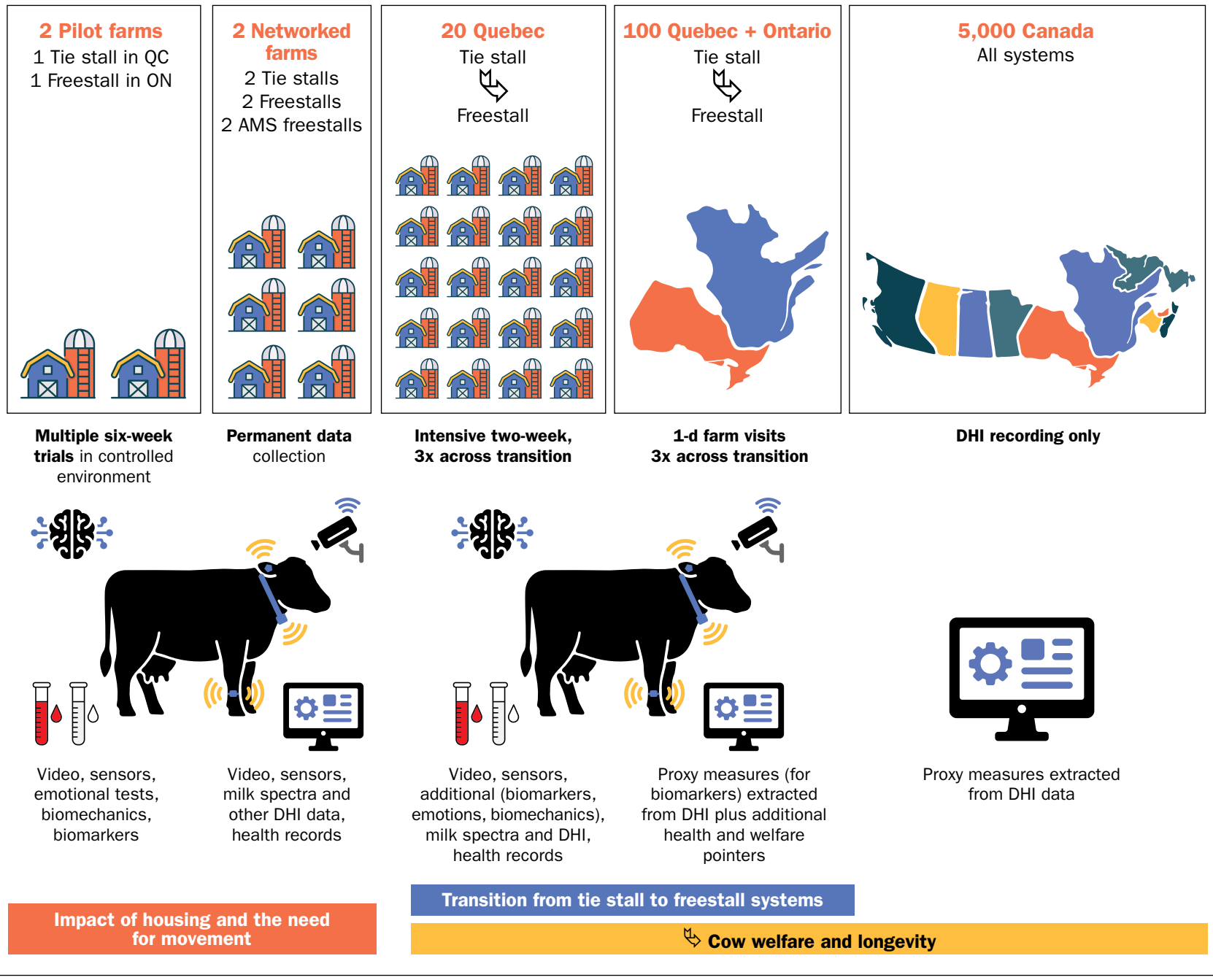
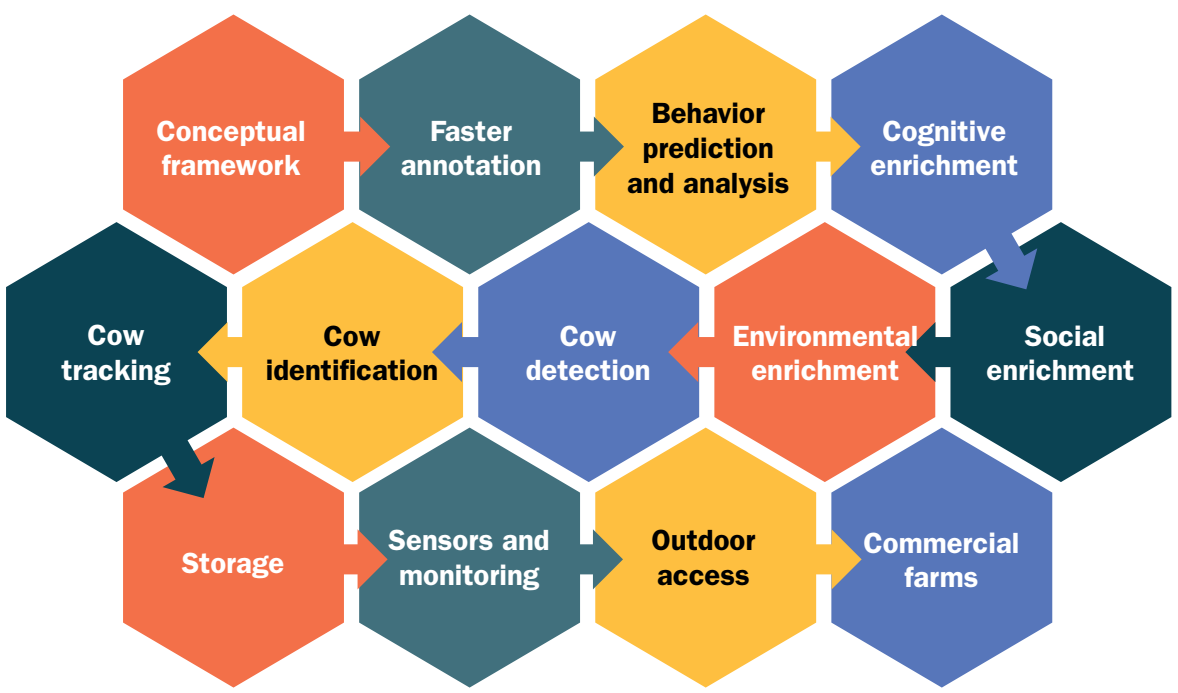


Figure 3. A visual representation of the complementarity of the joint laboratory, as defined by main research concepts



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identify early, subtle, or long-term changes that humans could easily miss. These combined strengths lead to technologies that are more sensitive, reliable, and adaptable to different types of farms. Ultimately, this improves welfare monitoring while also offering farmers practical advantages, such as earlier detection of health or behavioral issues, improved decision-making, and a clearer understanding of herd dynamics.

Practical solutions

Looking ahead, the WELL-E R+I Chair is paving the way for the next generation of on-farm technology. A major part of this effort involves building strong data infrastructures, cybersecurity systems, and new "federated learning" tools that allow farms to benefit from shared knowledge without compromising data privacy. These elements are essential for bringing AI-based solutions into everyday use on commercial dairies. At the

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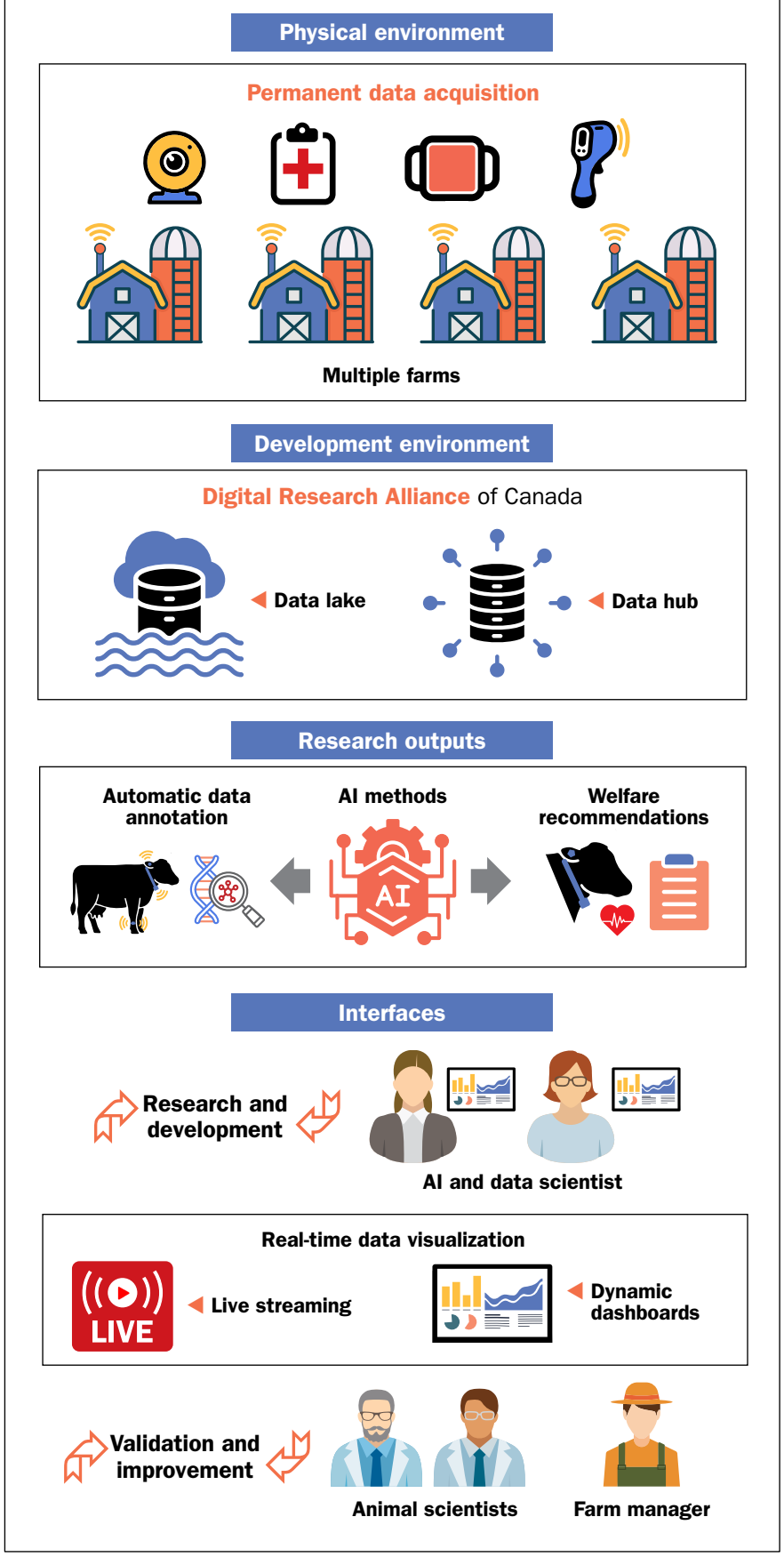
Figure 4. Summary of the R+I Chair Living Lab's functioning



same time, the chair is developing more advanced systems for automated behavior detection and computer vision. The goal is not only to record what cows are doing, but to anticipate what might be coming next, such as early signs of stress, discomfort, or illness. This move toward predictive monitoring has the potential to change how herds are managed, making it easier to spot problems early, adjust grouping strategies, or fine-tune comfort measures before issues escalate.

In the long term, these innovations will help us understand cattle more precisely. They also open the door to new decision-support tools that can guide day-to-day management with clearer, more reliable information. By bringing animal science and AI together, the WELL-E R+I Chair is helping shape a future where technology works alongside farmers to support healthier, more comfortable, and more productive herds. 1000+

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