Investigating Perceptions, Motivations, and Challenges in the Adoption of Precision Livestock Farming in the Beef Industry

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Abstract

Precision Livestock Farming (PLF) aims to automate and optimize the detection of illness, injury, and reproductive cycles in livestock through real-time automated data collection, analysis and reporting. While many researchers and farmers agree that PLF can help optimize farming practices and outcomes, in certain farming sectors there has been low adoption rates of PLF technologies. This research aims to investigate this low adoption in one key sector of the Canadian agricultural industry: beef farming. This early-stage project aims to employ a human-centred design approach to understand farmers' perceptions of PLF technologies, and potential challenges they face in adopting these technologies on their farms. We wish to determine whether there is a mismatch between the technology design and capabilities, and the needs of the technology users in this farming sector. This paper describes our planned research on this topic. Through surveys and interviews, we aim to understand how beef farmers and other relevant stakeholders perceive and value this technology, their motivations for adopting or not existing PLF technologies, what effect of the technology may have on animal welfare and health on beef farms, and potential challenges farmers face in adopting such technologies. Findings from this research may help in the future development of more usable and cost-effective technology for the beef industry, and potentially other farming sectors.

Index Terms: Human-centered computing—Ubiquitous computing; Human-centered computing—Mobile computing; Human-centered computing—Mobile devices; Applied computing—Agriculture; Applied computing—Health informatics

1 Introduction

Farming is a $69.4B industry in Canada, and livestock farming 47% of the total industry [6]. Beef farming accounts for a significant portion of the livestock industry. The 2016 Canadian Census of Agriculture [6] found that there were 4 times more beef cows than dairy cows being raised on Canadian farms (2.4M beef cows). Yet, similar to other sectors facing increased competition from global food suppliers and a changing workforce less willing to do dull, dirty work, the farming industry faces extreme pressure to be more efficient. Moreover, changing consumer demands for healthier, ethical food production also places pressures on livestock farmers to be more accountable in their animal rearing practices.

To meet these demands, many farmers are adopting "precision livestock farming" (PLF) practices, which uses advanced technologies to automatically monitor and manage livestock health, welfare, and production [2]. For example, specialized robots use radio frequency identification (RFID) tags to tailor feed and milk individual cows, sensors monitor animal growth and detect illness and disease [9].

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Although there has been wide adoption of certain PLF technologies, such as automated handling of feeds, excrement, bedding, and ventilation, the adoption of other PLF technologies, such as technologies designed to monitor the health and welfare of individual animals, have been slower, especially in certain livestock sectors. Based on our discussions with beef and dairy industry experts, for instance, there has been little to no uptake of health and welfare monitoring technologies in the beef industry, yet much wider adoption of these technologies in the dairy sector. There are likely many socioeconomic factors involved in this disparity, including regulatory differences between these sectors, as well as farming culture differences. However, it is important to better understand these issues to discover whether the current PLF technology do not meet beef farmers' needs or whether other factors are at play.

Another motivation behind this research is that PLF technologies have tremendous potential to improve food traceability within the beef industry. Prior efforts have explored technologies such as RFID [5] or biological makeup such as DNA marker [1] to improve food traceability in the beef industry. Yet, none of these efforts have been user-centric, and have focused largely on technological exploration instead of its actual usefulness to stakeholders. Without understand whether PLF technologies are valued and meet the needs of farmers, there will be little incentive to adopt them.

The goal of this research is to investigate beef farmers' perceptions of the benefits and limitations of current PLF technologies for assisting in their farming operations and decision-making. Other stakeholders in the beef industry will also be included in our study, such as veterinarians, regulatory board staff, food policymakers, and animal scientists. We are currently in the early stages of this research. The rest of this paper describes some relevant background for the project, and our planned research activities, including planned surveys and interviews with farmers and relevant stakeholders.

2 Related Work

The global population by 2050 is expected to reach 9.2 billion according to the UN Food and Agriculture Organization (FAO), to meet the demands of this growing population it is essential to leverage technology to ensure higher efficiency in growing food (crops and livestock). There have been several technological innovations in recent decades focused on various aspects of precision farming, there have been several works on field monitoring such as health monitoring which is often based on normalized difference vegetation index, crop scouting, yield monitoring and forecasting, detection of diseases, pests and weeds, and weather, irrigation and soil quality control and management [7].

Recent studies on the adoption of precision farming in Canada have investigated technology adoption in crop farming [3] and dairy farming [3, 8] . Using phone interviews, online surveys, and interviews, Tse et al. [8] investigated the impact of adopting automatic milking systems on milk quality and production. Duncan [3] investigated the impact of precision agriculture adoption on social relations between agricultural technology retailers and farmers in crop farming and dairy farming in Ontario by interviewing farmers and retailers. She also analyzed the 2016 Canadian Census of Agriculture, which collected data from across Canada on the adoption of certain farming technologies, such as automatic milking systems. Her research revealed implications on the accessibility of technology, adoption patterns, policy implication of adoption of precision agriculture, and changing social relationship between farmers and agricultural technology retailers. Our prior consultation of dairy and beef industry experts reveals that, to date, there has been a higher adoption of PLF technologies in Canada within the dairy industry than in the beef industry. To our knowledge, there has been no prior work on the adoption of PLF in the Canadian beef industry.

Another survey study by Steele [7] investigated precision agriculture adoption and barriers in Canada. The study found that 98% of farmers used at least one form of technology on their farm, for instance, 98% used wireless or cable internet and GPS. However, very few farmers surveyed used some of the more advanced technologies investigated, for instance, 28% used satellite imagery and only 19% used drone imagery for crop farming. This result is interesting because despite the fact that 93% of farmers that participated in this research agreed that precision agriculture technologies are useful there was still very low adoption of the more advanced technologies. This suggests that user-centric and participatory design approaches that seek to establish technological requirements that better suit the perspectives of farmers, policymakers, consumers and animals may be useful in this technology context. This research takes this view, and seeks to understand, for stakeholders in the beef industry, how well suited the current PLF technologies are for meeting their needs and perspectives.

3 Methodology

Our aim is to carry out this research from the point of view of each individual stakeholders to ensure that innovators and PLF researchers can implement a user-centric and cost-effective technology. For instance, in food traceability, it is important to understand the information needs of each individual stakeholder so as to ensure the right data are presented to them at the right time and place, the information requires by farmers to monitor the health of their animals will be different from what a final consumer need to make healthy food choice and might also be different from what a policymaker requires to make effective policy. Instruments that will be used in this study include focus groups, online surveys, and interviews. In this study, various stakeholders in the beef industry will be recruited to participate in the research, including farmers, policy makers, animal scientist, researchers, veterinarians, and consumers.

After recruiting the desired participant populations, an online survey will be designed for each category of participants and deployed. Users will be encouraged to include their name in this survey for the sake of follow-up interview if required. For most of the consumers there might not be a need for a follow-up interview but for farmers, veterinarians and animal scientist the major purpose of the questionnaire is just to ensure we effectively structure the interview questions and also reduce the number of questions that will be asked so as to reduce the interview time. The purpose of the focus group is to ensure that we cover as many farmers, veterinarians and other stakeholders as possible, instead of visiting a farm and interviewing farmers one after the other, we might be able to cover a larger population if this is done in groups.

For easy interpretation of the qualitative responses, we will develop codes based on an iterative inductive analysis approach [4]. The research team will read all responses and classify responses based on a relevant theme until we find a consistent set of themes that fit the responses and then carry out content analysis on the quantitative data. For the quantitative data we will make use of inferential statistics, regression to test the relationship between some factors and perceptions/adoption of technology, correlation to find out which factors affect perception and adoption and to what extent and analysis of variance will help to understand the difference between various stakeholders perception of PLF in the beef industry and how this affects their decision making.

4 Conclusion

To ensure farmers effectively leverage the precision technology in the management of their farm, researchers and innovator must understand their needs and requirements and also understand what influence their adoption of a technology and challenges they face. Besides farmers other stakeholders such as animal scientists, veterinarians and final consumers might also influence the adoption of a particular technology so understanding this stakeholders perception is also important to a successful implementation and deployment of a technology, for instance, farmers may decide not to use a technology if a retailer feels it has a negative side effect on the animal or crop. The successful completion of this research using an online questionnaire, interview and focus group will eliminate or reduce failed PLF innovations specifically in the beef industry but may be generalizable to other kinds of farming. It will provide an intuitive guide for researchers and innovators to develop user-centric and easily adoptable precision agriculture technology which will lead to more efficient farm practices, make more food available to feed the growing world population and more yield on investment for both the farmers and innovators.

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