A summary of U.S. Midwestern feedlot producer responses to precision livestock management technologies

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Abstract

Precision livestock management (PLM) uses innovative sensing tools, data analytics, and modeling techniques to support decision-making and advance animal production monitoring. However, there is limited effort focused on PLM applications specific to the beef cattle industry in the U.S. Unlike other species, beef production situates uniquely due to its extensive housing environment, with most operations being extensively outdoors. This major difference poses a significant challenge to the beef industry's development and adoption of modern PLM technologies. In addition, animal practitioners continue to question the application, commercial success, implementation possibilities, and economic benefits of PLM tools used in different beef cattle management systems. Thus, whether these techniques can bring new opportunities for PLM research and production in the beef industry – particularly the U.S. feedlot sector – requires further evaluation. A survey questionnaire was developed and distributed to Nebraska and adjacent states' commercial feedlot producers on their knowledge and needs regarding PLM technologies. Twelve questions captured producer feedback on 1) their PLM knowledge level; 2) their willingness, acceptance level, and strategy in adopting such technologies; 3) their biggest concerns in the daily feedlot operations; 4) PLM ideas/technologies that interest them; 5) their comfort level (dollar-for-dollar) on investing in PLM technologies, and 6) their role and operation size. The survey was well received by feedlot producers, with 78 completed surveys received. Survey results highlighted the significance, challenges, and opportunities of developing and evaluating PLM tools for the beef feedlot industry and covered more than 574,000 feedlot cattle managed. The results of the survey are summarized in this conference paper.

Keywords: beef cattle, extension, need assessment, questionnaire, survey

Introduction

Projections indicate that the global human population will exceed nine billion people by 2050. Such growth will require a 50 to 60 percent increase in food production (Raney, 2009; Tilman et al., 2011; van Dijk et al., 2021), demonstrating a need to double beef production (Alexandratos and Bruinsma, 2012; Terry et al., 2020) in the next 20-odd years to ensure adequate access to protein and mitigate threats to global food security. The importance of the beef industry in the United States is highlighted by the fact that its production accounted for $66.3 billion in cash receipts in 2019, compared to $21.7 billion for pork and $28.3 billion for broilers (USDA). Feedlots, as the proportion of total beef produced, contributed approximately 77 percent of the cattle marketed in the United States (Drouillard, 2018; USDA, 2019; Wagner et al., 2014), with the remainder coming from culled cows/bulls.

Serious concerns hamper our ability to ramp up feedlot production to meet demand. For example, in modern beef production systems, producers face difficulties providing desired levels of targeted care for increasing animal numbers per management unit (Beaver et al., 2020). This situation will be exacerbated by future labor shortages caused by challenging work environments, strenuous chores, and low-profit margins (Makinde, 2020) as well as increased risks associated with extreme weather events (Poudel et al., 2020). It is difficult to identify early signs of animal illness without quality animal care, and lack of detection limits opportunities for

producers to take timely action to prevent animal illness cases from worsening. Consequently, without innovative management strategy interventions, the future for beef production is characterized by a strong likelihood that beef cattle productivity, welfare, and health will be downgraded alongside feedlot producer profitability.

Precision livestock management (PLM, or precision livestock farming) uses innovative sensing tools, data analytics, and modeling techniques to support decision-making and advance animal production monitoring. PLM frameworks show great potential for revolutionizing animal production (Banhazi et al., 2012), and adoption offers livestock producers efficient tools to monitor individual or small groups of animals near real-time for improved animal health management via early disease prevention and immediate action (Wathes et al., 2008). In addition to assisting in managing animals on commercial farms, PLM tools can provide researchers conducting large-scale animal research with precise and continuous data streams of targeted animal groups (Condotta et al., 2020), which can be analyzed in multiple dimensions to develop new methods of animal management, evaluate phenotypes, and engineer better housing conditions. While many PLM studies have focused on improving the production, reproduction, health, and welfare of livestock animals (Berckmans, 2014), they have primarily focused on proof of concepts. Research on the successful commercialization of PLM technologies has been limited by lack of open access to and proprietary control in data ownership held by a small number of commercial companies (Banhazi et al., 2012). This situation remains valid across all livestock and poultry species and is a critical gap in our knowledge of PLM.

To date, there is limited effort focused on PLM application specific to the U.S. beef cattle industry. Unlike other species (e.g., swine, dairy, or poultry), beef production situates uniquely due to its extensive housing environment, with most operations being extensively outdoors, which is particularly true for the major beef production states that have dry climates. This major difference poses a significant challenge to the beef industry's development and adoption of modern PLM technologies. In addition, animal practitioners continue to question the application, commercial success, implementation possibilities, and economic benefits of PLM tools used in different beef cattle management systems in the U.S. Thus, whether these techniques can bring new opportunities for PLM research and production in the beef industry – particularly the feedlot sector – requires further evaluation. Although the beef sector has been historically slow in adopting modern technologies due to its unique management challenge, there has been an increasing interest arises in the emerging PLM area.

The objective of this effort was to develop a survey to obtain producers' feedback on their knowledge and needs regarding PLM technologies in commercial feedlots in midwestern U.S.

Survey questionnaire

This survey questionnaire was tailored for producers, managers, employees, or professionals whose work involves commercial feedlots in the state of Nebraska or adjacent states in the U.S. Twelve survey questions (six close-ended questions, five open-ended questions, and one demographic question) were designed to capture producer feedback on 1) their PLM knowledge level; 2) their willingness, acceptance level, and strategy in adopting such technologies; 3) their biggest concerns in the daily feedlot operations; 4) PLM ideas/technologies that interest them; 5) their comfort level (dollar-for-dollar) on investing in PLM technologies; and 6) their role and operation size. The feedback of this survey questionnaire is completely voluntary and anonymous, collected no personal information, and thus was exempted from the University of Nebraska-Lincoln's Institutional Review Board requirement (Determination Form ID: 59190). Uniquely for the U.S. feedlot industry, the location of the feedlot is among sensitive information producers usually prefer not to disclose. Therefore, to respect anonymous of the survey and producers' privacy, specific state and county were not asked in this survey questionnaire. The survey questions are listed as follows:

Close-ended questions (multiple choices provided):

1. Are you familiar with the concept of "Precision Livestock Management"? (yes/somewhat/no)
2. If you are not familiar with the concept, "precision livestock management" refers to tools that utilize real-time data on individual animals to aid management decisions. Would you consider using precision technology in your operation? (already using, very likely, somewhat likely, not likely)
3. What best describes your strategy in adopting technology (multiple answers)? (ROI, source of information/technology, ease to use/operate technology, other)
4. In which areas would you like to implement precision management technologies? Please rank from 1 to 6 (1 = most important; 6 = least important).
5. Is recruiting labor a concern at your operation? (yes/no/somewhere in the middle)
6. Which of the following precision management technologies interests you? Please rank from 1 to 5 (1 = most interested; 5: least interested).

Close-ended questions with an option to provide their own answer(s):

1. What is the capital cost you would be willing to invest in precision management technologies? (<$5, <$10, <$25, <$50, <$100)
2. Which of the following concerns would be most likely to prevent you from investing in such precision management technologies? (capital, ROI, knowledge of technology, reliable workforce to operate technologies, I am not a fan of technologies)
3. What is the biggest concern in the daily operations of your feedyard(s)? (cattle health, cattle welfare, recruiting labor, feed management, other)
4. What is your biggest animal health concern at your operation? (BRD, lameness, bloat, AIP, other)
5. What positions are the most difficult to fill (multiple answers)? (feedlot managers, pen riders, truck drivers, office staff, maintenance staff, other)

Demographical questions:

To protect the respondents' privacy, the only demographical questions asked were 1) the size of the operation(s) and 2) the position of the survey respondent.

Survey Distribution and Analysis

The survey questionnaires were distributed using a convenience sampling strategy as paper surveys to commercial feedlot professionals via local in-person Extension workshops/meetings as the sole avenue. Descriptive statistics were performed for close-ended questions and the average ranking method was used to analyze ranking survey questions. For the close-ended questions with an option to provide their own answers, the raw answers were input and analyzed as another multiple choice.

Survey result highlights

The survey was well received by feedlot producers with 78 completed surveys received (over 90% return rate). Survey results highlighted the significance, challenges, and opportunities of developing and evaluating PLM tools for the beef feedlot industry and covered more than 574,000 feedlot cattle managed (20-22% of all cattle on feed in Nebraska). Summary survey observations include: most respondents were feedlot owners or managers (62.1%), with the remainder being feedlot employees, office staff, and industry consultants. Due to the limited space allowance for this conference paper, not all survey questions' results are provided here. A list of result highlights is provided below:

- Thirty percent reported being familiar with PLM, 47% were somewhat familiar, and 23% were not familiar.
- Only 12% (of 77 responses) reported that they have started to use PLM technologies; 39% were very likely, 45% were somewhat likely, and 4% were not likely to use PLM.
- The best strategies identified for adopting technology were: return on investment (54.5%), source of information/technology (20.8%), ease to use/operate the technology (31.2%), and other specified (3.9%). Most people had only one strategy to identify PLM (68 of 77 responses).
- The biggest concerns in daily feedlot operations were identified as: cattle health (38.5%), recruiting labor (28.6%), cattle welfare (14.3%), feed management (12.1%), and other (6.6%). This order matches with another question asked about the most needed areas where they would implement PLM technologies (i.e., illness detection, labor-saving, precision feed management, and welfare enhancement).
- Forty-one percent reported difficulties in finding pen riders (for health assessment in pens), 17% for truck drivers (for feed delivery estimation), and the rest were maintenance staff (26%) or feedlot managers (10%).
- Return on investment was the leading answer (48.3%) for the producers' strategy in adopting certain technologies.
- Thirty-one percent of respondents were willing to invest less than $5/head, 38 percent were comfortable with a range between $5-10/head, 24 percent selected $10-25/head, and 7 percent selected the next option ($25 – 50/head).

Conclusions

These survey responses showed that U.S. feedlot producers want access to PLM knowledge and tools. The survey results also reveal the challenges and realities they face to accept and adopt such practices, including price-point. Producers' strategy and comfort level on investment explain why particular technologies have not widely increased in commercial viability. The highlighted challenges, such as producers concerns over technological operation and break-even cost benefits should be recognized and received because of the distinct challenge and management practices that exist in the U.S. feedlot sector.

References

Alexandratos, N., and Bruinsma, J. (2012) World agriculture towards 2030/2050: the 2012 revision. *FAO Agricultural Development Economics Division* 12-03, 133.

Banhazi, T.M., Lehr, H., Black, J., Crabtree, H., Schofield, P., Tscharke, M., and Berckmans, D. (2012) Precision livestock farming: an international review of scientific and commercial aspects. *International Journal of Agricultural and Biological Engineering* 5(3), 1-9.

Beaver, A., Proudfoot, K.L., and von Keyserlingk, M.A. (2020) Symposium review: Considerations for the future of dairy cattle housing: An animal welfare perspective. *Journal of Dairy Science* 103(6), 5746-5758.

Berckmans, D. (2014) Precision livestock farming technologies for welfare management in intensive livestock systems. *Revue Scientifique et Technique* 33(1), 189-196.

Condotta, I.C.F.S., Brown-Brandl, T.M., Pitla, S.K., Stinn, J.P., and Silva-Miranda, K.O. (2020) Evaluation of low-cost depth cameras for agricultural applications. *Computers and Electronics in Agriculture* 173, 105394.

Drouillard, J.S. (2018) Current situation and future trends for beef production in the United States of America—A review. *Asian-Australasian Journal of Animal Sciences* 31(7), 1007.

Makinde, A. (2020) *Investigating perceptions, motivations, and challenges in the adoption of precision livestock farming in the beef industry* (Doctoral dissertation, University of Guelph).

Poudel, P.B., Poudel, M.R., Gautam, A., Phuyal, S., Tiwari, C.K., Bashyal, N., and Bashyal, S. (2020) COVID-19 and its global impact on food and agriculture. *Journal of Biology and Today's World* 9(5), 221.

Raney, T. (2009) *The state of food and agriculture: livestock in the balance*. Food and Agriculture Organization of the United Nations, Rome, Italy.

Terry, S.A., Basarab, J.A., Guan, L.L., and McAllister, T.A. (2020) Strategies to improve the efficiency of beef cattle production. *Canadian Journal of Animal Science* 00, 1-19.

Tilman, D., Balzer, C., Hill, J., and Befort, B.L. (2011) Global food demand and the sustainable intensification of agriculture. *Proceedings of the National Academy of Sciences* 108(50), 20260-20264.

USDA (Feb 2022) Economic Research Service: Cash receipts by selected commodity, 2013-2022F. *https://data.ers.usda.gov/reports.aspx?ID=17832.*

USDA (2019) Census of Agriculture, c2017. USDA, National Agricultural Statistics Service (AC-17-A-51). *https://www.nass.usda.gov/Publications/AgCensus/2017/index.php#full_report.*

van Dijk, M., Morley, T., Rau, M.L., and Saghai, Y. (2021) A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. *Nature Food* 2, 494–501.

Wagner, J.J., Archibeque, S.L., and Feuz, D.M. (2014). The modern feedlot for finishing cattle. *Annual Review of Animal Biosciences* 2(1), 535-554.

Wathes, C.M., Kristensen, H.H., Aerts, J.M., and Berckmans, D. (2008) Is precision livestock farming an engineer's daydream or nightmare, an animal's friend or foe, and a farmer's panacea or pitfall? *Computers and Electronics in Agriculture* 64(1), 2-10.