Drivers of Technological Adoption in Beef Production: Insights from the Missouri Red Angus Association

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Introduction

Technological advancements and innovative production strategies are essential for enhancing efficiency, sustainability, and public perception of the U.S. beef industry (Piña et al., 2023). Understanding what drives technological adoption is critical to strengthening the beef industry's ability to navigate 21st-century challenges, including climate change (Rotz, 2019), shifting consumer expectations (Liu et al., 2022), and the growing demand for global protein (Piña et al., 2023). As global markets evolve and consumer demands shift**,** innovation will be key to ensuring the industry remains competitive against competitive protein options (Komarke et al., 2021). By identifying the factors that encourage innovation and support technological adoption, industry, extension professionals, and researchers can develop strategies to engage with producers on the benefits of emerging technologies.

Theoretical Framework

This study is situated within Davis's (1989) Technology Acceptance Model (TAM). TAM proposes technological advancement is adapted on the basis of two factors: perceived usefulness and perceived ease of use. These factors shape an individual's attitude toward technological advancements, which leads to the determination of technological adoption. Perceived usefulness is described as the degree in which someone believes a specific technological advancement will improve performance or productivity, whereas perceived ease of use is the degree in which the individual believes the technological advancement to be easy to learn, implement, and operate without extensive effort (Davis, 1989). In the context of this study, we examine what factors process predictive influence in a producer's adaptation of technological advancements, illustrating perceived usefulness and ease of use. This framework provides a lens to explore why beef producers decide whether to adopt innovative production practices and technology.

Methods

The purpose of this study was to explore the factors that had the strongest predictive influence on the adoption of three innovative/technological production practices among Missouri Red Angus Association (MORAA) members. The three practices examined were rotational grazing, embryo transfer (ET), and the use of electronic identification (EID) ear tags. These practices were selected due to their demonstrated impact on sustainable production (Badgery et al., 2017), enhanced genetic performance (Karisch & Parish, 2024), and improved data tracking in production systems (Aleluia et al., 2022; Puig et al., 2022). A survey was administered during the 2024 MORAA stakeholders' meeting in April 2024, gathering responses from 32 participants (n = 32). The instrument comprised 40 questions designed to collect data on demographic characteristics, production characteristics, and adoption of the three specific technological/innovative production practices.

To identify the most influential predictors of technological adoption, we employed a forward stepwise logistic regression model (James et al., 2013). This method systematically evaluated 14

survey variables as potential predictors, beginning with a null model and iteratively adding variables that improved model fit based on Akaike Information Criterion (AIC). Forward subset selection was chosen because it allows for efficient use of limited data, optimizes predictive accuracy, and minimizes the risk of overfitting (James et al., 2013). Due to the small sample size, the model was constrained to include a maximum of three predictor variables per final model. This approach provides a structured, data-driven means of understanding which factors most strongly predict producers' adoption of these key technological advancements.

Results

For embryo transfer (ET), 62% (n = 20) of producers reported using ET in their systems. Among these, 28.71% of their breeding stock utilized ET (*95% CI*: 16.87%, 40.56%). The final model identified *trust in the MORAA* as a significant predictor (β = 2.71, $p = 0.038$, OR = 15.09). Although not statistically significant, the model also retained marital status (β = -2.15, $p = 0.101$, $OR = 0.12$) and a *"big picture" management approach* (β = 1.61, $p = 0.127$, $OR = 5.00$). The intercept was β = -1.197 ($p = 0.291$). For rotational grazing, 81.25% (n = 26) of respondents indicated using this practice. The final model retained one variable, *years in the beef industry* (β = -0.06, $p = 0$, $OR = 0.94$) and it was a significant predictor. The intercept was β = 3.253 ($p = 0.010$). For electronic identification (EID) ear tags, 56.25% (n = 18) of respondents reported using this technology. The final model identified *trust in the MORAA* (β = 3.19, $p = 0.017$, $OR = 24.22$) and *expected herd growth over the next five years* (β = 2.03, $p = 0.038$, $OR = 7.55$) as significant predictors. Additionally, having a *four-year degree or higher* (β = 1.62, $p = 0.097$, $OR = 5.05$) was retained, though not statistically significant. The intercept was β = -4.68 ($p = 0.007$). The model findings highlight the role of trust in MORAA, industry experience, and future herd growth expectations in shaping technological adoption among MORAA producers.

Conclusion/Discussion/Recommendations

This study provides insight into factors that have predictive influence on adopting technological advancements and innovative production practices within the MORAA. Trust in the MORAA emerged as a positive significant predictor for ET and the use of EID ear tags, suggesting producer confidence in industry organizations influences technology implementation (Li et al., 2008). Further, years in the beef industry had a negative impact on rotational grazing, highlighting the challenge of encouraging change amongst experienced producers (Tey & Brindal, 2012). Expected herd growth also positively impacted the likelihood of using EID ear tags, showing the impact of growth on technological adoption (Ruzzante et al., 2021). These models, situated within TAM, demonstrate *who* is engaging with technological advancements and *why* they are being implemented (perceived ease of use and usefulness), yet more information is needed to assess *how* communication, outreach, and extension-oriented practices are impacting producers' willingness to engage with technological advancements. Future research should explore barriers to adoption and address how producers are deciding to implement technological and innovative practices.

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