

Mitigating the Impact of HPAI on Dairy Farms: Bridging Knowledge Gaps in Crisis Communication, Biosecurity, and Public Health

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Abstract: The cross-species spread of Highly Pathogenic Avian Influenza H5N1 to U.S. dairy cattle in 2024 highlights urgent biosecurity and communication challenges. This mixed-methods study analyzes survey data from 266 Vermont dairy farms and social media analytics of global data from 29 million exposures and 558 government accounts. Key findings reveal 14% of farms introduced unquarantined heifers, 76% of farms lacked quarantine facilities for returning animals, 77% omitted post-exhibition isolation, 86% housed cats, and 27% had frequent wild bird interactions. Social media themes like “Food Supply”, “Die of Bird Flu”, “Farm Worker”, and “Drink Raw Milk” dominated discourse in association with H5N1 and dairy, with sentiment analysis showing 59% negative public perception. The IDEA model (Internalization, Distribution, Explanation, Action) is proposed as a theoretical framework to counter misinformation and enhance communication efficacy. Recommendations include infrastructure investment, community-driven communication, and leveraging local networks to build biosecurity resilience.

Keywords — farm survey, HPAI H5N1, IDEA model, risk communication, social media

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INTRODUCTION

Highly Pathogenic Avian Influenza (HPAI) H5N1, historically confined to avian species, has increasingly infected dairy cattle, cats, and pigs, signaling a concerning shift in its epidemiological trajectory. Several reports of HPAI outbreaks in dairy farms in the U.S in 2024 prompted urgent regulatory action from federal agencies such as the USDA [1]. Despite these efforts, compliance with biosecurity guidelines remains inconsistent, exacerbated by misinformation circulating on social media platforms. This study investigates the intersection of biosecurity practices and crisis communication efficacy among Vermont dairy farmers, leveraging the IDEA model to develop actionable interventions.

LITERATURE REVIEW

Recent research demonstrates HPAI’s capacity for cross-species transmission to dairy cattle, cats, and pigs, underscoring

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the virus's adaptability and the need for revised biosecurity frameworks [2]. The emergence of HPAI in cattle has escalated into a critical concern due to its dual threat: infected herds experience significant declines in milk production, leading to economic losses for farmers, and the disease demonstrates zoonotic potential, with the CDC reporting 70 human cases in the U.S. since Q2 2024 [3]. Risk and crisis communication scholarship emphasizes the utility of the IDEA model in structuring risk messaging during outbreaks, particularly in agricultural settings where misinformation can hinder communication efficacy [4]. Prior studies note that risk perceptions are shaped by a connection of factors, such as governmental directives, peer networks, and digital narratives [5]. These findings align with this study's focus on Vermont's communication landscape, where social media plays a pivotal role in disseminating both credible guidance and harmful misinformation.

METHODS

This study integrated surveys of Vermont dairy farms and sentiment analysis of HPAI-related social media content. Survey questions assessed biosecurity protocols, animal movement practices, and communication preferences across a stratified quasi-randomized sample of Vermont dairy farms. The study targeted all milk-shipping operations in 2010, approximately 1,000 farms, mailing 500 surveys to achieve a 5% margin of error with 95% confidence, yielding 266 completed responses. Additionally, social media analytics collected from January 2023 to August 2024 through Sprinklr, a leading social media listening tool, evaluated global data from 558 government accounts and more than 29 million user exposures to HPAI content, identifying trends in public engagement. The IDEA model—structured around Internalization (message relevance), Distribution (channel efficacy), Explanation (clarity), and Action (specific steps)—guided the analysis of communication strategies.

RESULTS

Survey findings in [Figure 1](#) revealed critical biosecurity gaps: 14% of farms introduced replacement heifers that had commingled with animals on other farms into their herd (76 % of which had no quarantine facilities). Sixteen percent participated in livestock exhibitions (77% of these omitted isolation measures), while 86%, 14%, and 29% housed non-dairy animals such as cats, pigs, and poultry, respectively, creating potential reservoirs or vectors for viral transmission. Additionally, frequent wildlife interactions, particularly with wild birds' hunts (27%) near livestock areas, were reported.

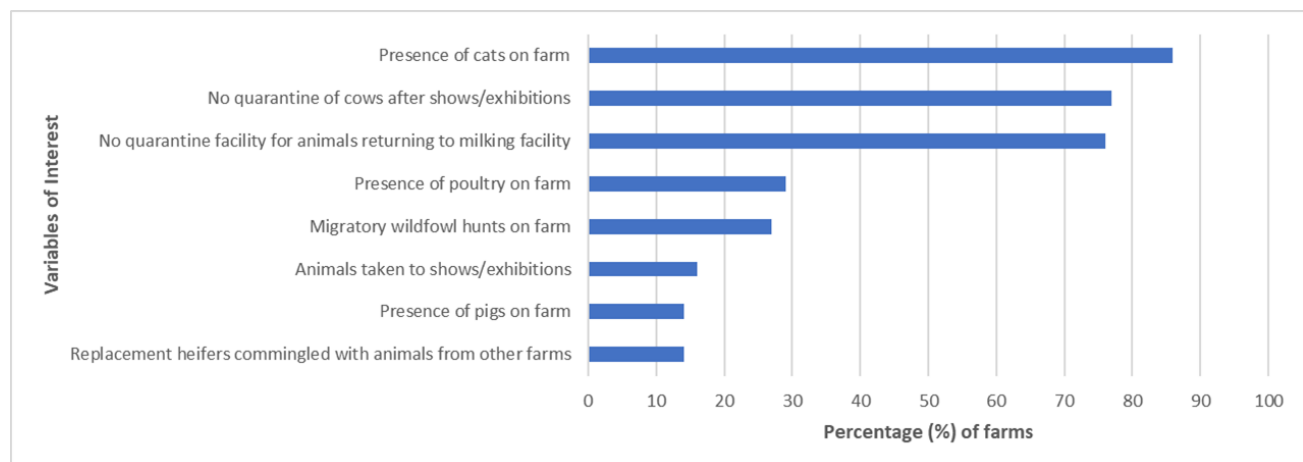


Figure 1: Survey findings from 266 Vermont dairy farms showing the % of farms reporting these variables of interest

[Figure 2](#) identified Q2 2024 as the peak period for HPAI discourse. A sentiment analysis of the posts showed a negative perception of the outbreak and the risk of contamination in humans, indicating users' concerns with the risk.

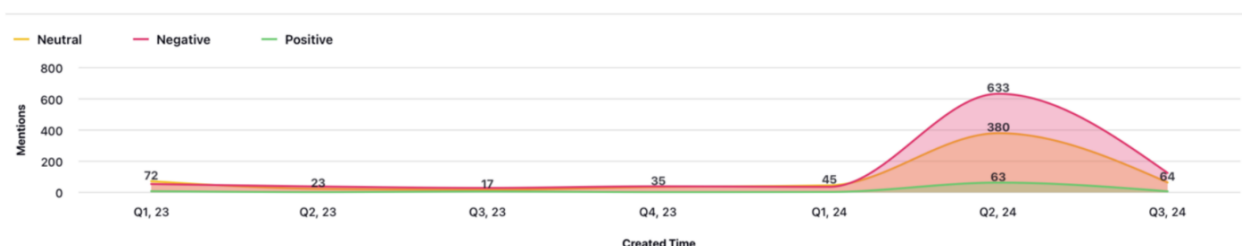


Figure 2: Sentiment analysis of HPAI posts on social media

In [Figure 3](#), thematic analysis of HPAI-related social media discourse identified *bird flu* as the dominant theme, followed by *food supply*, *die of bird flu*, *farm worker*, and *drink raw milk*.

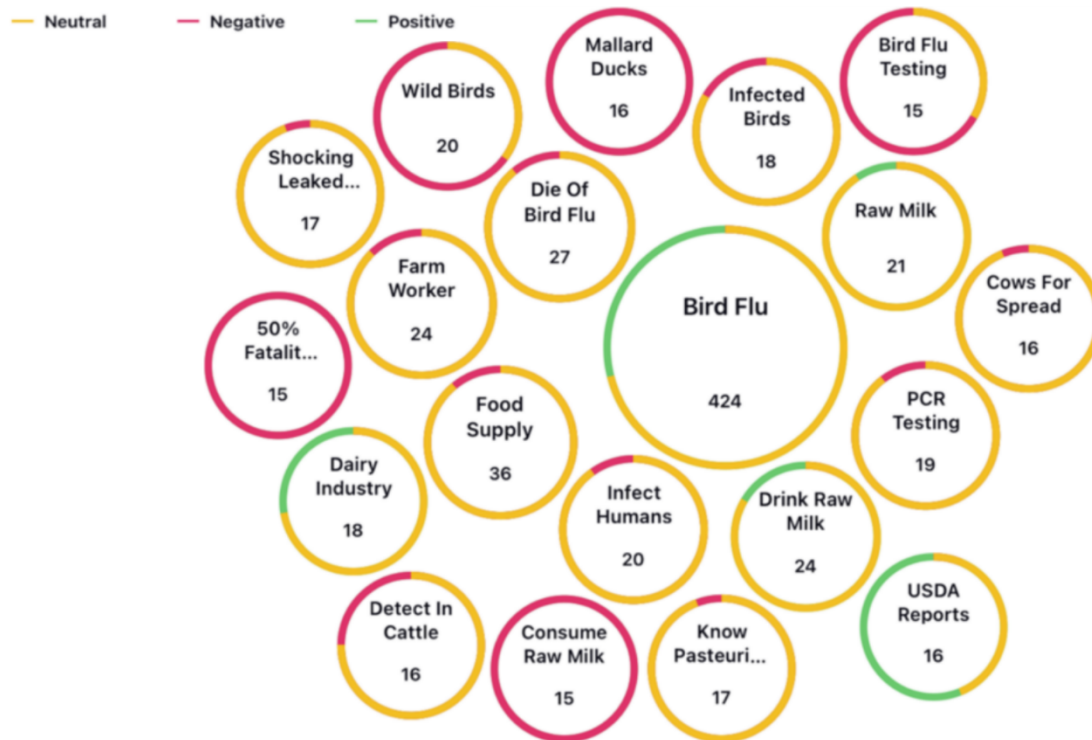


Figure 3: Social media analysis of themes about HPAI discourse

DISCUSSION

The findings highlight critical gaps in biosecurity and the pervasive influence of social media narratives on risk perception and public health. Social media narratives exacerbate high-risk practices by distorting risk perceptions, amplifying economic fears, and eroding trust in science—creating a feedback loop that prioritizes short-term survival over sustainable biosecurity. The commingling and livestock exhibition practices, compounded by the presence of non-dairy animals and wild bird interactions, align with Caserta et al.'s [2] warnings about cross-species viral reservoirs. Such risks are exacerbated by logistical constraints (e.g., lack of quarantine infrastructure) and misaligned priorities, where operational efficiency may overshadow biosecurity.

The frequency of HPAI mentions underscores the surge in public discourse during Q2 2024, with themes like “food supply”, “die of bird flu”, and “drink raw milk” dominating. These themes reflect heightened public anxieties about food safety, zoonotic transmission, and public health. The sentiment analysis reveals that 59% (633 out of 1,076) of social media sentiment was negative, driven by fears of human transmission and economic disruption. This negativity risks amplifying non-compliance with suggested best management practices, as fear-based narratives may overshadow official guidelines if not countered by proactive, culturally resonant messaging. This is because such negative sentiments could amplify public anxiety and economic fears during the outbreak, further pressuring farmers to prioritize short-term productivity over biosecurity—exacerbating high-risk practices such as commingling livestock and omitting quarantine protocols, while undermining trust in science-based guidelines.

The IDEA model offers a structured approach to address these challenges. For instance, workshops led by local veterinarians could enhance Internalization by contextualizing risks, while Action-oriented guidelines (e.g., health-oriented worker behavior like wearing Personal Protective Equipment) could address practical barriers. Limitations include regional bias and self-reported survey data, which may inflate biosecurity implementation. Future studies should evaluate the longitudinal impacts of IDEA-based interventions across diverse agricultural regions.

CONCLUSION

This study identifies systemic biosecurity gaps and the pervasive role of social media in shaping risk perceptions during the 2024 HPAI H5N1 outbreak in the U.S dairy sector. High-risk practices, such as commingling livestock and omitting quarantine protocols, are exacerbated by dominant social media themes like “Food Supply” and “Die of Bird Flu”, indicative of public anxiety. Negative social media sentiments distort public risk perceptions, heighten economic pressures to maintain production, and erode trust in regulatory guidance. The high proportion of negative sentiments on social media underscores the urgency of proactive, trust-based communication. Policymakers could prioritize infrastructural support (e.g., quarantine facilities) and collaborate with local leaders to disseminate actionable guidance via the IDEA framework.

Strengthening communication pathways between federal agencies, veterinarians, and farmers is critical to mitigating zoonotic risks and safeguarding agricultural economies.

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