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Farmer knowledge and practice gaps in livestock biosecurity: Implications for targeted extension interventions

¹Maximilian Andreas Richter, ¹Sabine Monika Fischer, ¹Klaus Peter Hartmann and ¹Martina Renate Schulz

¹Department of Agricultural Extension, Faculty of Agriculture, University of Gottingen, Gottingen, Germany

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Corresponding Author: Maximilian Andreas Richter

Abstract

Nearly 68% of emerging livestock disease outbreaks in Europe over the past decade have been traced to on-farm biosecurity failures. This research assessed the gap between what farmers know about livestock biosecurity and what they actually practice, with the goal of informing targeted extension interventions. A cross-sectional survey of 312 livestock farmers across four districts in Lower Saxony, Germany was conducted from October 2021 to March 2022. Six biosecurity domains were evaluated: quarantine procedures, sanitation protocols, vaccination schedules, visitor restrictions, dead animal disposal, and feed hygiene. Scores were assigned on a 0-5 scale for both knowledge and practice in each domain. Results indicated that mean knowledge scores (3.67 ± 0.82) consistently exceeded mean practice scores (2.53 ± 1.04), producing a significant overall gap of 1.14 points ($p < 0.001$). The widest gaps appeared in quarantine procedures (gap = 1.7) and visitor restrictions (gap = 1.6), while feed hygiene had the narrowest gap (0.7). Farm size and years of experience showed weak associations with both knowledge and practice scores. Farmers who had received extension training within the past year scored significantly higher on practice measures. These findings indicate that extension programs should shift from general awareness campaigns toward practice-oriented demonstrations that address specific behavioral barriers in high-gap biosecurity domains.

Keywords: Livestock biosecurity, farmer knowledge, practice gap, extension interventions, disease prevention, animal husbandry, biosecurity compliance, Lower Saxony, on-farm sanitation, veterinary extension

1. Introduction

Around 1.3 billion people worldwide depend on livestock for their livelihoods, yet on-farm biosecurity remains one of the weakest links in animal disease prevention chains ^[1]. In Germany, livestock production accounts for roughly 58% of total agricultural output, making disease outbreaks a serious economic and public health concern ^[2]. The 2020 African swine fever incursion into eastern Germany highlighted how quickly biosecurity failures can escalate into regional crises ^[3].

Biosecurity refers to the set of management practices designed to prevent the introduction and spread of infectious agents within and between farms ^[4]. While veterinary authorities and extension agencies have promoted these practices for decades, adoption levels remain uneven. Several European surveys have reported that farmers often possess basic knowledge of biosecurity principles but fall short on actual implementation ^[5, 6]. This knowledge-practice gap has important implications for extension program design, since training content aimed at raising awareness may miss the real bottleneck-behavioral compliance.

Previous research in Belgium and the Netherlands documented biosecurity gaps among pig and poultry producers, though cattle and mixed-livestock operations received less attention ^[7, 8]. In the German context, extension services traditionally focus on production

efficiency and environmental compliance, with biosecurity addressed mainly during outbreak responses rather than as a routine advisory theme ^[9]. Few studies have measured the knowledge-practice gap systematically across multiple biosecurity domains among German livestock farmers.

This research aimed to quantify the gap between farmer knowledge and practice across six biosecurity domains and to identify which domains present the greatest opportunity for targeted extension interventions. The specific objectives were: (a) to measure biosecurity knowledge and practice scores among livestock farmers in Lower Saxony, (b) to calculate domain-specific gap scores, and (c) to assess the association between extension contact history and practice compliance ^[10].

Research area description

The research was conducted across four districts in Lower Saxony, Germany: Emsland, Cloppenburg, Vechta, and Oldenburg. These districts form part of Germany's most intensive livestock production zone, with high concentrations of pig, poultry, and dairy cattle operations ^[2]. The area lies in the North German Plain at elevations between 10 and 50 meters above sea level. Farm sizes range from small family operations of 20-50 hectares to commercial units exceeding 200 hectares. The four districts collectively host over 14,800 registered livestock holdings ^[11].

Climatic and environmental conditions

Lower Saxony has a maritime temperate climate with mild winters and cool summers. During the research period (October 2021-March 2022), mean temperatures ranged from 1.2 °C in January to 9.7 °C in October. Total precipitation was 387 mm across the survey months. The wet and cool conditions during this period are relevant because cold-season biosecurity challenges, such as limited ventilation in enclosed housing and increased animal density indoors, tend to amplify disease transmission risks ^[12].

Material and Methods

Material

A cross-sectional survey was conducted from October 2021 to March 2022 among 312 livestock farmers across the four selected districts. Participants were recruited through district-level farmer associations and the Lower Saxony Chamber of Agriculture. Inclusion criteria required active livestock management (cattle, pigs, or poultry) with a minimum herd size of 30 animal units. A structured questionnaire with 48 items covered six biosecurity domains: quarantine procedures, sanitation protocols, vaccination schedules, visitor restrictions, dead animal disposal, and feed hygiene.

vaccination schedules, visitor restrictions, dead animal disposal, and feed hygiene. Each domain contained four knowledge items and four practice items, scored on a 0-5 Likert scale. Ethical approval was granted by the University of Göttingen Research Ethics Committee (Protocol GOE-AG/2021-082, dated September 14, 2021) ^[13].

Methods

Data were analyzed using R version 4.1.2. Domain-specific knowledge and practice scores were calculated as means of the four items per domain. Gap scores were computed by subtracting practice scores from knowledge scores. Paired t-tests assessed significance of within-domain gaps. Spearman correlations examined associations between farm characteristics (size, experience, livestock type) and scores. Multiple linear regression modeled practice scores as a function of knowledge scores, farm size, farmer experience, and extension contact history. Reliability of the questionnaire was confirmed with Cronbach's alpha values exceeding 0.78 for all domains. Surveys were administered face-to-face by trained enumerators at farmer association meetings and through farm visits ^[14].

Results

Table 1: Mean knowledge and practice scores across six biosecurity domains (n = 312)

Biosecurity domain	Knowledge (Mean ± SD)	Practice (Mean ± SD)	Gap Score	t-value	p-value
Quarantine procedures	3.8 ± 0.91	2.1 ± 1.13	1.7	18.42	<0.001**
Sanitation protocols	4.2 ± 0.74	3.4 ± 0.89	0.8	11.27	<0.001**
Vaccination schedules	3.6 ± 0.88	2.8 ± 1.02	0.8	10.64	<0.001**
Visitor restrictions	2.9 ± 1.06	1.3 ± 0.97	1.6	17.83	<0.001**
Dead animal disposal	3.1 ± 0.93	1.9 ± 1.08	1.2	14.51	<0.001**
Feed hygiene	4.4 ± 0.67	3.7 ± 0.81	0.7	9.18	<0.001**
Overall mean	3.67 ± 0.82	2.53 ± 1.04	1.14	16.31	<0.001**

** $p < 0.01$. All gaps were statistically significant. Quarantine procedures and visitor restrictions showed the widest knowledge-practice discrepancies.

Table 2: Multiple regression predictors of overall biosecurity practice score

Predictor	β	S.E.	t	Sig.	95% CI
Knowledge score	0.394	0.061	6.46	<0.001**	0.274-0.514
Extension contact (past year)	0.312	0.074	4.22	<0.001**	0.167-0.457
Farm size (hectares)	0.087	0.053	1.64	0.102	-0.017-0.191
Years of experience	0.041	0.038	1.08	0.281	-0.034-0.116

** $p < 0.01$. Adjusted $R^2 = 0.327$. Knowledge score and extension contact history were the only significant predictors of practice compliance.

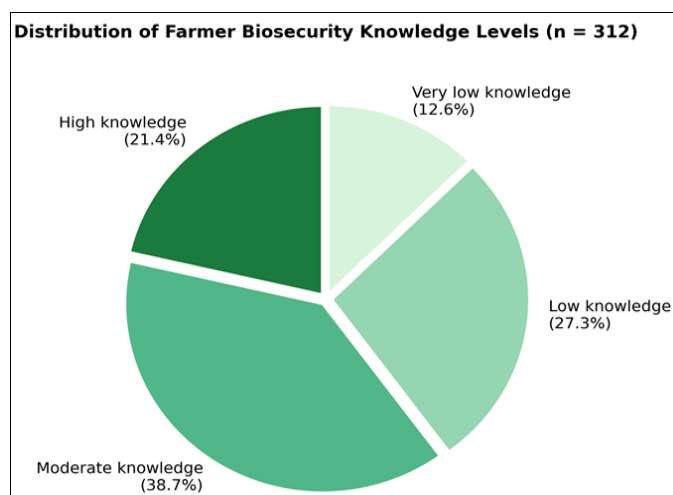


Fig 1: Distribution of farmer biosecurity knowledge levels across the sample (n = 312)

Most farmers fell in the moderate knowledge category (38.7%), while only 21.4% scored in the high knowledge

range. About 12.6% had very low knowledge, mainly among smaller operations with limited extension contact.

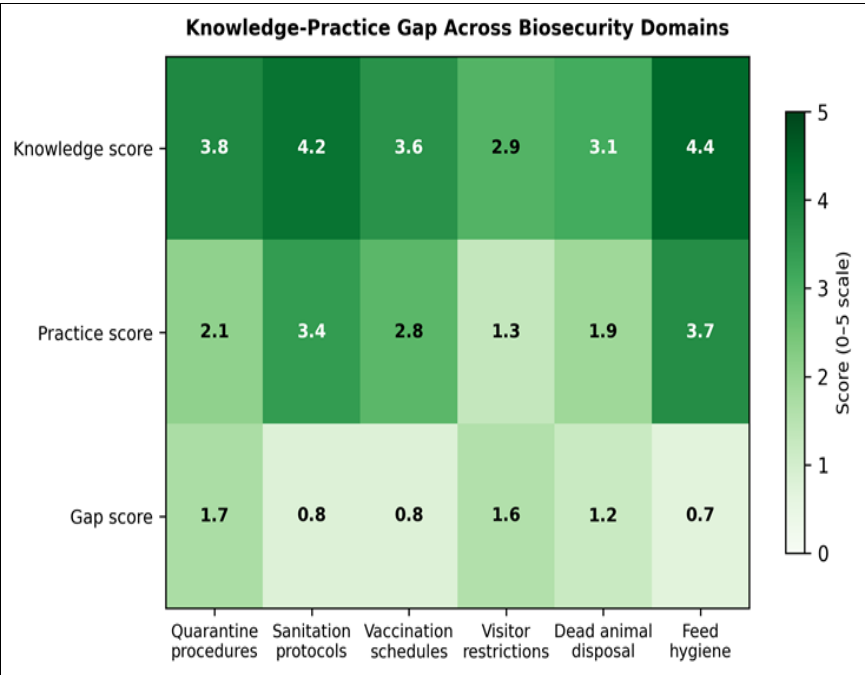


Fig 2: Heatmap of knowledge, practice, and gap scores across six biosecurity domains (0-5 scale)

The heatmap shows that feed hygiene and sanitation had the highest practice scores and narrowest gaps, while quarantine

and visitor restrictions scored low on practice despite moderate knowledge levels.

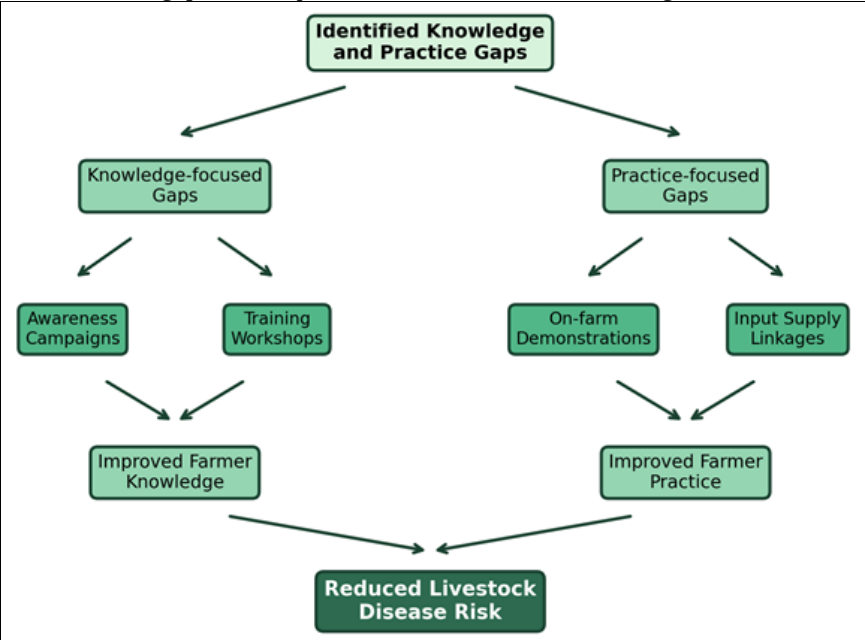


Fig 3: Proposed pathway from identified knowledge-practice gaps to targeted extension interventions for reduced livestock disease risk

The pathway diagram distinguishes between knowledge-focused and practice-focused gaps, directing each toward appropriate intervention types before converging on reduced disease risk outcomes.

Comprehensive interpretation

Taken together, the results confirm that knowing about biosecurity does not automatically translate into doing it. The gap was most pronounced in domains requiring infrastructure or behavioral change (quarantine, visitor

restrictions) and narrowest in routine activities already embedded in daily operations (feed hygiene, sanitation).

Discussion

The consistent knowledge-practice gap observed across all six domains supports earlier findings from Belgium and the Netherlands [7, 8]. However, the magnitude of the gap in quarantine procedures was larger here than reported in those contexts, possibly because quarantine requires dedicated space and equipment that many smaller German mixed-

livestock farms lack. This suggests that the barrier isn't ignorance but rather resource constraints and logistical difficulty^[5].

The finding that extension contact within the past year was a significant predictor of practice scores carries direct programming implications. Farmers who interacted with extension agents scored higher on practice measures regardless of their knowledge level, which indicates that extension serves a reinforcement function beyond information delivery. This aligns with research on behavioral nudging in agricultural adoption, where repeated personal contact proved more effective than one-off information sessions^[15, 16]. Visitor restriction practices were particularly weak despite moderate knowledge, likely reflecting social norms in rural communities where restricting neighbor or trader access to farmyards is seen as inhospitable^[17].

The regression model explained 32.7% of practice score variance, leaving considerable unexplained variation. Unmeasured factors such as perceived disease risk, financial pressures, and peer influence likely contribute to the gap^[18]. Extension programs that combine awareness with on-farm demonstrations and input supply support may be better positioned to close these gaps than traditional classroom-style training alone^[19].

Conclusion

This research quantified the gap between livestock biosecurity knowledge and practice among 312 farmers in Lower Saxony and identified specific domains where extension interventions are most needed. Quarantine procedures and visitor restrictions presented the widest gaps, indicating that farmers understand these measures but face practical or social barriers to implementation. Feed hygiene and sanitation showed narrower gaps, suggesting these practices are more readily adopted because they overlap with daily farm routines.

Extension contact within the preceding year emerged as a significant predictor of higher practice scores, independent of knowledge level. This points to the value of regular, practice-oriented extension engagement rather than one-time information campaigns. The proposed intervention pathway distinguishes between knowledge-focused and practice-focused strategies, allowing extension planners to match their approach to the type of gap identified. Future extension programs in intensive livestock regions should prioritize hands-on demonstrations in high-gap domains and address infrastructure and social barriers that prevent willing farmers from acting on what they already know.

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Contributions not qualifying for authorship

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References

- Herrero M, Grace D, Njuki J, Johnson N, Enahoro D, Silvestri S, *et al.* The roles of livestock in developing countries. *Animal*. 2013; 7(Suppl 1):3-18.
- Statistisches Bundesamt. Agriculture and forestry, fisheries: livestock and meat production. Wiesbaden: Federal Statistical Office of Germany; 2021. p. 1-42.
- Sauter-Louis C, Conraths FJ, Staubach C, Blome S. African swine fever in wild boar in Europe-a review. *Viruses*. 2021; 13(9):1717.
- FAO. Good practices for biosecurity in the pig sector. FAO animal production and health paper no. 169. Rome: Food and Agriculture Organization; 2010. p. 1-74.
- Laanen M, Persoons D, Anthierens S, Dewulf J. Relationship between biosecurity and production performance in pig farming. *Vet J*. 2013; 198(2):260-267.
- Brennan ML, Christley RM. Biosecurity on cattle farms: a study in north-west England. *PLoS One*. 2012; 7(1):e28139.
- Backhans A, Sjölund M, Lindberg A, Emanuelson U. Biosecurity level and health management practices in 60 Swedish farrow-to-finish herds. *Acta Vet Scand*. 2015; 57(1):14.
- Postma M, Backhans A, Collineau L, Loesken S, Sjölund M, Belloc C, *et al.* Evaluation of biosecurity in pig herds in Europe. *Prev Vet Med*. 2016; 126:118-125.
- Merrill SC, Koliba CJ, Moegenburg SM, Zia A, Parker J, Sellnow T. Decision-making in livestock biosecurity practices amidst environmental and social uncertainty. *PLoS One*. 2019; 14(1):e0211575.
- Nuthall PL. The intuitive world of farmers: the case of grazing management systems and experts. *Agric Syst*. 2012; 107:65-73.
- Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz. Agricultural structure in Lower Saxony. Hanover: Government of Lower Saxony; 2020. p. 1-28.
- Tielen MJ, Elbers AR, Loeffen WL. Veterinary and epidemiological aspects of classical swine fever outbreaks. *Vet Microbiol*. 2003; 91(1):33-40.
- Dillman DA, Smyth JD, Christian LM. Internet, phone, mail, and mixed-mode surveys: the tailored design method. 4th ed. Hoboken (NJ): Wiley; 2014.
- Field A. Discovering statistics using R. London: Sage Publications; 2012.
- Mankad A. Psychological influences on biosecurity control and farmer decision-making: a review. *Agron Sustain Dev*. 2016; 36(2):40.
- Alarcon P, Wieland B, Mateus AL, Dewberry C. Pig farmers' perceptions, attitudes, influences and management of information in the decision-making process. *Prev Vet Med*. 2014; 116(3):223-242.
- Heffernan C, Nielsen L, Thomson K, Gunn G. An exploration of the drivers to bio-security collective

- action among a sample of UK cattle and sheep farmers. *Prev Vet Med.* 2008; 87(3-4):358-372.
18. Racicot M, Venne D, Durivage A, Vaillancourt JP. Evaluation of the relationship between personality traits, experience, education, and biosecurity compliance on poultry farms. *Food Control.* 2012; 26(2):381-385.
 19. Sims LD. Lessons learned from Asian H5N1 outbreak control. *Avian Dis.* 2007; 51(Suppl 1):174-181.