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## Evaluation of Transportation GPS Technology to Assess Biosecurity Route and Downtime Procedure Compliance


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### Introduction

Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) and Porcine Epidemic Diarrhea Virus (PEDV) continue to present major challenges to the U.S. swine industry, with outbreaks reported year-round. In April 2025, the Swine Disease Reporting System recorded the highest PRRSV positivity rate since 2018, with grow-finish sites being most affected.[1] Holtkamp et al. linked increased site activity to a greater likelihood of disease outbreaks.[2] Previous work indicates that excluding human movement from assessments can underestimate outbreak risk.[3] These findings highlight the risk of indirect disease transmission via vehicles, personnel, and other fomites. Despite detailed biosecurity protocols, compliance with practices (e.g., vehicle routing, downtime) remains insufficiently monitored due to limited real-time data and alerting. Digital platforms such as Farm Health Guardian (FHG) may offer a potential solution by automating movement traceability and downtime enforcement.[4,5]

### Objective

This study evaluated the effectiveness of GPS-based technology in enhancing visibility and improving compliance with transportation-related biosecurity protocols.

### Materials and Methods

*Experimental Design & System Enrollment*

An observational study was conducted within the wean-to-finish segment of an integrated swine production system. The FHG platform was integrated with the company's GPS tracking system (GPS Trackit™) to monitor real-time vehicle movement and biosecurity compliance. Feed trucks and fleet vehicles (e.g., vehicles, maintenance trucks) servicing the wean-to-market phase of production were monitored. Geofences were established around each production site to record vehicle entries and exits throughout the study period. Biosecurity rules were established within the FHG platform to align with the production system's biosecurity pyramid and downtime requirements. The downtime requirements for entering swine sites changed depending on the farm's current health status. Site health statuses were updated weekly from the production system and synchronized with the FHG platform to apply appropriate movement restrictions.

*GPS Data Management*

The FHG program recorded the vehicle name, GPS device ID, visit date, and duration, and the FHG-assigned health status of the site associated with the biosecurity breach.

Given the early implementation phase of the FHG platform, additional quality control was performed, including review of breach logs for duplicate events, verification of geofence accuracy, and confirmation that weekly site health status updates were successfully synchronized to the FHG platform. Repeated breach alerts at a single site signaled potential geofence inaccuracies and prompted verification and correction. Sites with more than one pig health status during the trial were excluded to preserve the integrity of biosecurity flow evaluations. Properties identified as having incorrect geofence locations or placements at any time point were removed from the dataset. Moreover, duplicate biosecurity breaches and those with visit durations shorter than 5 minutes or longer than 1,440 minutes were excluded.

*Biosecurity Breach Alert Assessment*

The study was conducted in two periods: Period 1 (7 weeks) served as a baseline, during which initial geofences and biosecurity criteria were monitored and refined; and Period 2 (10 weeks) involved monitoring vehicular events and biosecurity alerts and aligning operational biosecurity expectations. Activity-level data were collected before and after FHG implementation, as well as following refinements to the technology adaptation. Key evaluation areas included compliance with downtime and adherence to biosecurity pyramid protocols by vehicle type. Biosecurity breach alerts were categorized by type and production phase to identify high-risk patterns.

*FHG Platform Refinements*

Between study periods 1 and 2, the FHG biosecurity breach rules within the biosecurity pyramid were revised to better align with the production system's downtime expectations. Specific tiers for disease-positive statuses were created within the biosecurity pyramid color schemes, detailing the required number of days of downtime based on the specified disease(s) and site health status across different production phases in the system. A site with a “Blue” health status was considered vaccinated for PRRSV; however, it was negative for wild-type PRRSV, PEDV, *Mycoplasma Hyopneumoniae* (MHP), and Porcine Delta Corona Virus (PDCoV). A site with a “Red” health status would be positive for one or more of the following swine diseases: PRRSV, PEDV, MHP, or PDCoV. For example, the biosecurity pyramid states that one night of downtime is required after traveling from a red site to another. The production system would allow same-day travel from a PRRSV-positive red site to a site positive for both PRRSV and PEDV. In doing so, the company’s biosecurity requirements across systems were maintained, and compliance was monitored via the FHG platform.

*Statistical Analysis*

Data were analyzed descriptively to summarize vehicle movement events and biosecurity downtime breach alerts by study period, vehicle type, and biosecurity pyramid status.

**Results**

Between periods 1 and 2, median weekly downtime biosecurity breaches declined from 223 to 89 (Table 1). Feed truck breaches declined from 94 to 38.5, while median fleet vehicle breaches declined from 129 to 50.5 (Table 1; Figure 1). The sum of red biosecurity status site breach counts for feed trucks and fleet vehicles was numerically higher than that for blue biosecurity status sites in periods 1 and 2 (Table 2).

Feed trucks in the wean-to-market phases of production observed the highest total number of biosecurity breaches, regardless of period, followed by nursery, supervisor, finishing manager, and maintenance

vehicles, respectively (Table 3). Feed truck and fleet vehicle breaches were tracked over time and sorted by site health status color (Figures 2 and 3).

**Discussion**

Implementing the FHG platform improved visibility of transportation-related biosecurity compliance, though several refinements were required to optimize data accuracy. Geofences required review and adjustments to ensure accurate site boundaries, and GPS coordinates were verified to reduce false breach alerts. Using the FHG platform revealed that the production system authorized movements not captured in the existing biosecurity pyramid. Following an initial monitoring period (Period 1), rule and geofence refinements more accurately captured downtime biosecurity breaches within the wean-to-market system. They were accompanied by a reduction in breaches observed during Period 2. Accordingly, an initial trial period is recommended to verify GPS data integration and confirm that geofences are correctly placed and functioning as intended. Differences in observed breach frequency by vehicle type are hypothesized to reflect differences in visit frequency and operational roles. In addition, FHG enabled the generation of example outbreak reports, supporting traceability by modeling exposure timelines and identifying high-risk contacts.

Timely site health status updates were essential for accurate movement classification. During the study, site health status changes were communicated to FHG on a weekly schedule; however, diagnostic testing within the production system could confirm a new disease up to 7 days earlier. In these instances, production staff may have operated as if a site's health status had already changed before FHG reflected the update, potentially triggering false breach alerts.

Overall, these findings suggest that real-time, GPS-based monitoring can enhance compliance with transport and vehicle biosecurity measures and increase awareness of the risk of breaches. Broader adoption of such technology may strengthen adherence to protocols and support more effective disease prevention and response strategies within swine production systems.

**References**


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5. Mainquist-Whigham, C., Andersen, K., and Boakes, A. 2025. Improving transport biosecurity and reducing the risk of disease spread with biosecurity management software. Proceedings of the 56th Annual Meeting of the American Association of Swine Veterinarians. https://doi.org/10.54846/am2025/51

**Tables**

Table 1. Weekly median biosecurity downtime breaches by study period

| | Period 1* | Period 2* |
|---|---|---|
| Feed Trucks | 94 | 38.5 |
| Fleet Vehicles | 129 | 50.5 |
| Total Breaches | 223 | 89 |

*Period 1 duration was 7 weeks. Period 2 duration was 10 weeks.

Table 2. Sum of biosecurity downtime breaches by health status category

| | Health Status Color | |
|---|---|---|
| | Blue* | Red* |
| Period 1** | | |
| Feed Trucks | 194 | 441 |
| Fleet Vehicles | 317 | 483 |
| Total Breaches | 511 | 924 |
| | | |
| Period 2** | | |
| Feed Trucks | 101 | 205 |
| Fleet Vehicles | 277 | 333 |
| Total Breaches | 378 | 538 |

*Blue health status consisted of PRRSV vaccinated sites. Red health status consisted of positive sites for one or more of the following swine diseases: PRRSV, PEDV, MHP, or PDCoV.

**Period 1 duration was 7 weeks. Period 2 duration was 10 weeks.

Table 3. Sum of vehicle biosecurity breaches by period

| | Period 1* | Period 2* | Overall |
|---|---|---|---|
| Vehicle Type | | | |
| Feed Trucks | 635 | 306 | 941 |
| Nursery Vehicle | 365 | 157 | 522 |
| Finish Manager | 83 | 284 | 367 |
| Supervisor | 193 | 48 | 241 |
| Maintenance | 129 | 108 | 237 |
| Market Trucks | 26 | 10 | 36 |
| Whitewash Vehicle | 20 | 0 | 20 |
| Power Wash Vehicle | 0 | 1 | 1 |
| Total Breaches | 1,451 | 914 | 2,365 |

*Period 1 duration was 7 weeks. Period 2 duration was 10 weeks.

**Figures**

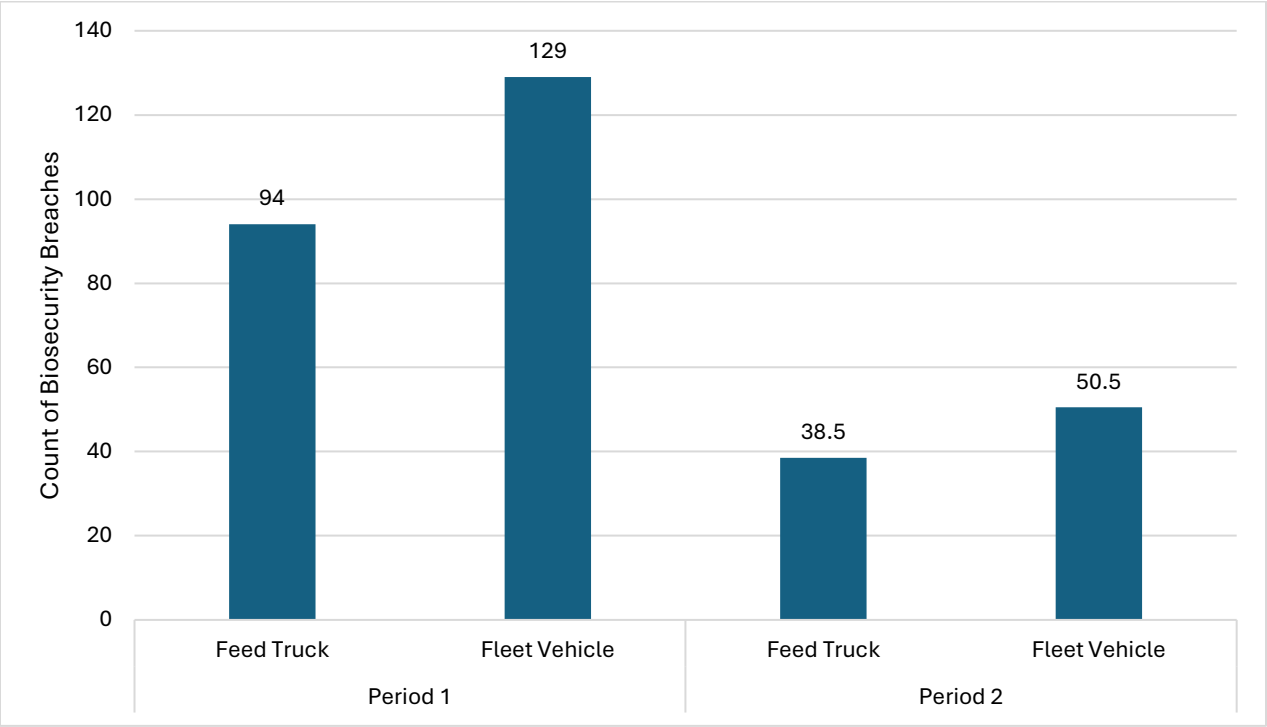


Figure 1. Weekly median biosecurity downtime breaches by study period

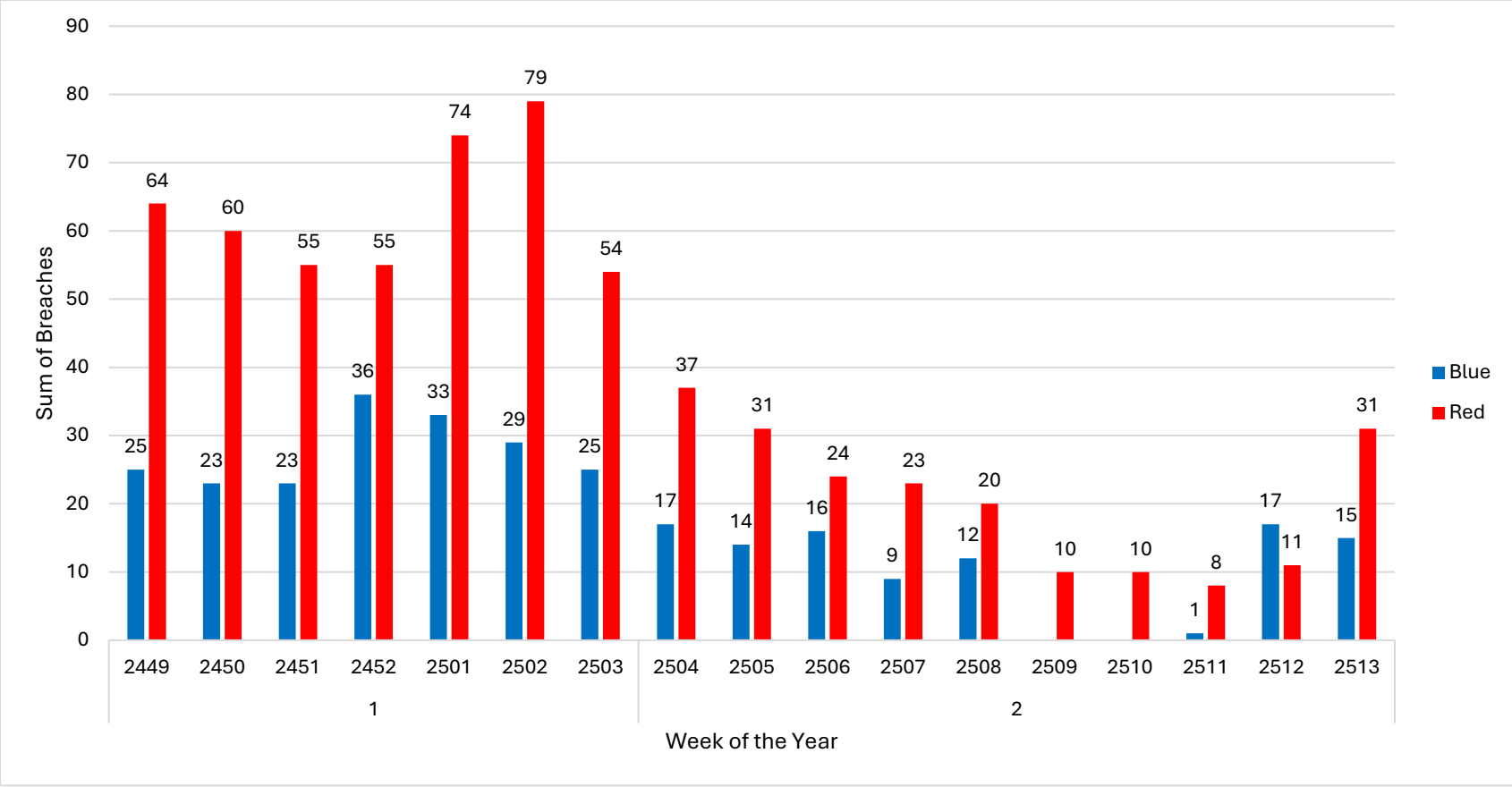


Figure 2. Feed truck downtime breaches by health color status over time

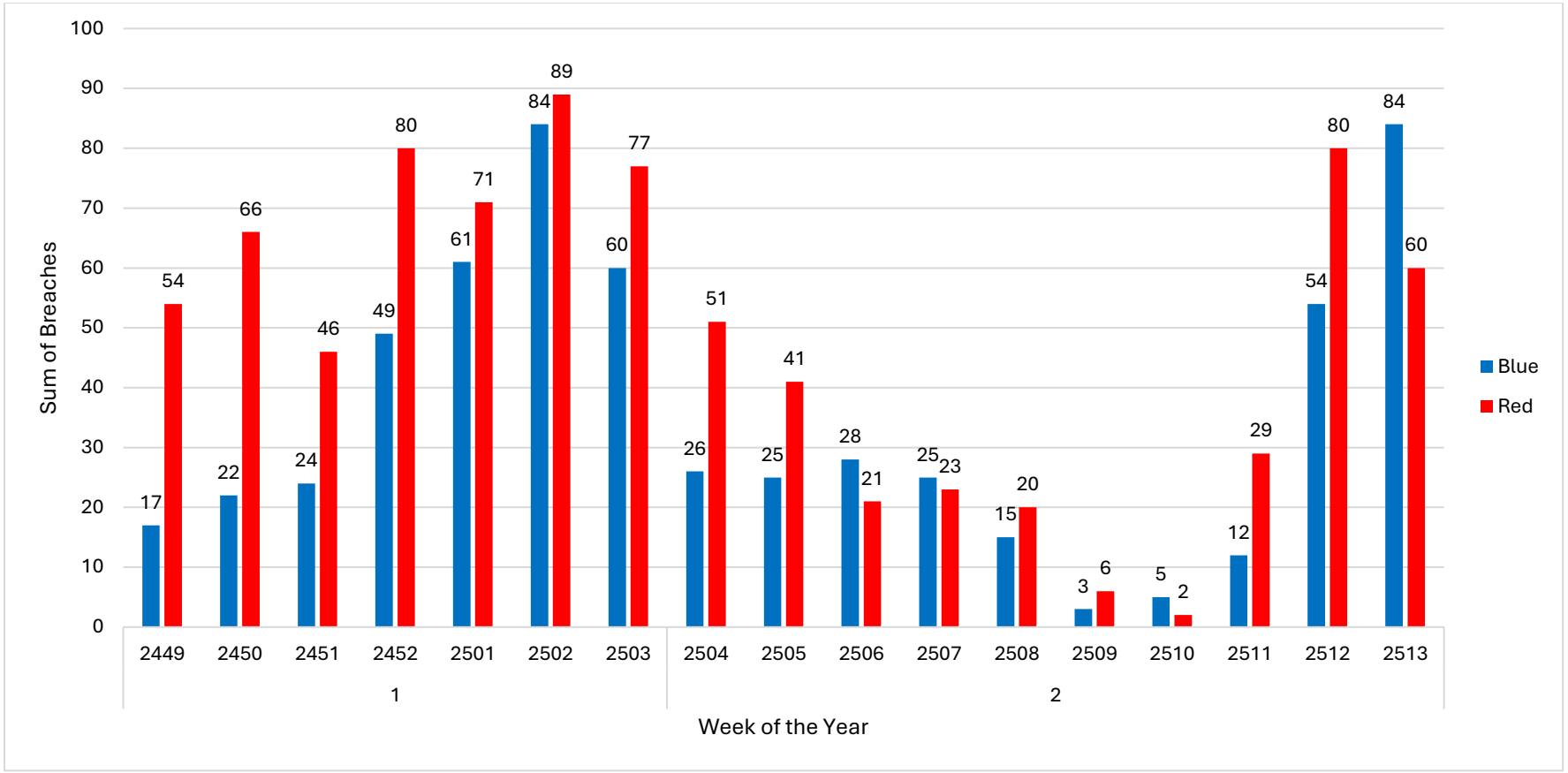


Figure 3. Fleet vehicle downtime breaches by health color status over time