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Biosecurity Compliance among Swine Farmers in Akwanga Local Government Area of Nasarawa State, Nigeria

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Abstract

This study examined compliance with biosecurity practices among intensive swine farmers in Akwanga Local Government Area of Nasarawa State, Nigeria. A multistage sampling procedure was adopted in selecting 80 swine farmers for the study. Primary data were collected using a structured questionnaire, while descriptive statistics and multiple regression analysis were employed for data analysis. Findings reveal that farmers were largely within their economically active age group (42 years), maintained moderate herd sizes (21 pigs). High cost of biosecurity materials (56.3%) and limited access to veterinary services were identified as major constraints. The regression results indicated that socioeconomic and institutional factors significantly influenced biosecurity compliance. Household size (β = 0.944; p < 0.01), education (β = 0.084; p < 0.01), and biosecurity awareness (β = 6.320; p < 0.01) positively influenced compliance. The study concludes that compliance with biosecurity practices among intensive swine farmers is significantly shaped by farmers' socioeconomic characteristics and their level of awareness of biosecurity measures. Enhancing farmer education, awareness programmes, and veterinary support services is essential for improving biosecurity compliance and minimizing disease risks in swine production systems.

Keywords: Biosecurity, compliance, Swine production, Disease prevention

Introduction

Intensive swine production has emerged as an important component of livestock development strategies aimed at improving household income, employment generation, and animal protein supply in developing economies, particularly where increasing urbanization and population growth have stimulated demand for pork and other livestock products (Fasina et al., 2012; Kouam et al., 2019; Laanen et al., 2013). Among intensive swine farmers, production systems characterized by confinement housing, controlled feeding, improved breeding management, and regular health supervision have progressively replaced traditional extensive systems in order to enhance productivity and market competitiveness (Campler et al., 2024; Kouam et al., 2018). In

Nigeria, pig production under intensive management continues to expand due to pigs' high reproductive efficiency, rapid growth rate, and ability to convert feed resources efficiently into meat within a relatively short production cycle (Fasina et al., 2012).

Despite the economic advantages associated with intensive swine farming, disease outbreaks remain one of the most serious constraints limiting enterprise sustainability and profitability. Intensive management systems increase stocking density and animal contact rates, thereby creating favourable conditions for rapid transmission of infectious diseases when preventive health measures are poorly implemented (Laanen et al., 2013; Ngom et al., 2024). Transboundary animal diseases such as African Swine Fever (ASF) have repeatedly caused severe production losses in pig-producing regions of Nigeria and other parts of Africa, resulting in high mortality rates, farm closures, and significant financial setbacks for farmers (Fasina et al., 2012; Ogundijo et al., 2023). Empirical evidence indicates that many disease outbreaks at farm level are associated with lapses in sanitation practices, unrestricted movement of people and animals, improper disposal of carcasses, and introduction of infected breeding stock into existing herds (Nantima et al., 2016; Bedekelabou et al., 2022).

Biosecurity practices are widely recognized as the most effective and economically sustainable approach for preventing disease occurrence in intensive livestock production systems. Farm biosecurity comprises a combination of structural, operational, and behavioural measures aimed at preventing the introduction and spread of pathogens within livestock farms (Campler et al., 2024; Ngom et al., 2024). These measures include restriction of visitor access, routine disinfection of equipment and housing facilities, quarantine of newly introduced animals, isolation of sick stock, controlled feed and water sources, and safe waste disposal mechanisms. Studies across pig production systems have shown that farms demonstrating higher levels of biosecurity compliance experience reduced disease incidence, improved herd productivity, and lower dependence on antimicrobial treatments (Laanen et al., 2013; Kouam et al., 2018).

However, compliance with recommended biosecurity standards among swine farmers in developing countries remains inconsistent and often inadequate. Farmers frequently adopt selected biosecurity practices rather than implementing comprehensive protocols due to limited technical knowledge, financial limitations, labour constraints, and weak veterinary extension support systems (Awosanya et al., 2015; Nantima et al., 2016). In Nigeria, assessments of livestock farms have revealed varying levels of adherence to biosecurity guidelines, with many producers lacking structured disease prevention plans despite awareness of associated risks (Aiyedun et al., 2018; Awoyomi et al., 2022). Poor compliance has consequently been identified as a major factor contributing to recurring outbreaks of infectious diseases within pig production systems (Ogundijo et al., 2023).

In Nasarawa State, particularly in Akwanga Local Government Area, intensive swine farming has increasingly developed as a viable agribusiness enterprise due to expanding market opportunities and favourable production conditions. Nevertheless, recurring reports of disease outbreaks and productivity fluctuations among pig farms suggest weaknesses in farm-level biosecurity implementation. Previous studies

conducted in Nigeria and other African countries indicate that even where farmers possess basic awareness of disease prevention measures, actual compliance is often influenced by socioeconomic characteristics, farm size, management experience, and access to veterinary advisory services (Kouam et al., 2019; Bedekelabou et al., 2022). The absence of location-specific empirical evidence on the level of biosecurity compliance among intensive swine farmers in Akwanga LGA limits effective planning of livestock health interventions and extension programmes. Understanding farmers' compliance behaviour is essential for identifying management gaps that expose farms to disease risks and for promoting sustainable intensive swine production systems. Assessing compliance with biosecurity practices will therefore provide critical information required to strengthen disease prevention strategies, improve herd health management, and enhance productivity and profitability among intensive swine enterprises in the study area. Accordingly, this study assessed biosecurity compliance among intensive swine farmers in Akwanga Local Government Area of Nasarawa State, Nigeria. The specific objectives were to:

1. examine pig farmers' socioeconomic characteristics;
2. assess the level of awareness of recommended biosecurity practices among the swine farmers;
3. determine the level of compliance with recommended measures;
4. analyse factors influencing compliance; and
5. ascertain constraints limiting compliance with biosecurity practices.

Methodology

The study was conducted in Akwanga Local Government Area of Nasarawa State, Nigeria. The area lies between latitudes 8°05′ and 9°00′ N and longitudes 8°15′ and 8°30′ E. It shares boundaries with Sanga Local Government Area of Kaduna State to the north, Nasarawa-Eggon to the south, Wamba to the east, and Kokona to the west. Akwanga has a population of 113,430 people (NPC, 2006), with farming serving as the predominant occupation of the inhabitants. The area was selected because of the significant presence of intensive swine farming activities. A multistage sampling procedure was adopted for the selection of pig producers in the study area. In the first stage, Akwanga Local Government Area was purposively selected because of prominence of pig farmers in the area. In the second stage, four out of the nine districts in the Local Government Area were purposively chosen because of the presence of notable intensive pig farms in the areas. They were Andaha, Nunku, Gudi and Gwanje. The third stage involved a systematic random selection of four communities from each of the two districts giving a total of eight communities. The fourth stage involved a purposive selection of only intensive pig farmers out of the total number of registered pig farmers as obtained from village extension agent. Out of the 239 registered pig farmers, 80 were identified to be operating the intensive pig management system, while the other 159 operated either the extensive or semi intensive management system. The 80 identified intensive pig farmers were drawn as the sample size for the study. Primary data was the main source of information for this study. The data were collected with the aid of well-structured questionnaire and interview schedule.

Data collected for this study were analysed using descriptive and inferential statistical tools. Descriptive statistics comprising frequency distribution, percentages, means, and standard deviation were used, while multiple regression analysis was employed to determine the factors influencing compliance with biosecurity practices among intensive swine farmers.

The level of awareness of biosecurity practices among intensive swine farmers was measured using a list of recommended biosecurity measures obtained from established livestock health guidelines and previous empirical studies (Laanen et al., 2013; Kouam et al., 2018; Ngom et al., 2024). Respondents were asked to indicate whether they were aware or not aware of each biosecurity practice. Awareness responses were scored as follows:

Aware = 1

Not aware = 0

An individual farmer's Biosecurity Awareness Index (BAI) was computed as:

$$BAI = \frac{\sum Ai}{N}$$

Where:

BAI = Biosecurity Awareness Index

Ai = awareness score for each practice

N = total number of biosecurity practices listed

The awareness index ranged from 0 to 1, where higher values indicated greater awareness of biosecurity practices.

Compliance with biosecurity practices was assessed by asking farmers to indicate the extent to which each recommended biosecurity measure was implemented on their farms.

Compliance level was measured using a three-point scale:

Fully practiced = 2

Partially practiced = 1

Not practiced = 0

A Biosecurity Compliance Index (BCI) was computed as:

$$BCI = \frac{\sum Ci}{2N}$$

Where:

BCI = Biosecurity Compliance Index

Ci = compliance score for each practice

N = total number of respondents

2 = highest score on the three point scale

The compliance index ranged from 0 to 1, with higher values indicating better compliance with recommended biosecurity measures.

Factors influencing compliance with biosecurity practices among intensive swine farmers were analysed using multiple linear regression analysis, since the compliance index is continuous in nature.

The implicit functional relationship is expressed as:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, e)$

The explicit model is specified as:

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+e$$

Where:
Y = Biosecurity Compliance Index
X1 = Age of farmer (years)
X2 = Household size (number)
X3 = Educational level (years of schooling)
X4 = Farming experience (years)
X5 = Herd size (number of pigs)
X6 = Access to veterinary services (1 = Yes, 0 = No)
X7 = Membership of farmers' association (1 = Yes, 0 = No)
X8 = Biosecurity awareness index
β0 = Intercept
β1–β8 = Regression coefficients
e = Error term

Results and Discussion

Socio-economic Characteristics of Swine Farmers

The socio-economic characteristics of swine farmers are closely linked with management decisions and the level of compliance with farm biosecurity practices. The results presented in Table 1 provide insight into the demographic and production background of the respondents involved in intensive swine production in Akwanga Local Government Area of Nasarawa State.

The age distribution showed a mean age of 42 years, with the majority of farmers (44.0%) falling within the 41–50 years age group. This indicates that swine production in the study area is largely undertaken by individuals within their economically active years. Farmers within this productive age category are more capable of adopting improved husbandry and disease prevention practices due to accumulated farming experience and economic responsibility. This finding is consistent with Oyegbami et al. (2024), who reported a mean age of 47.5 years among pig farmers in Lagos State, indicating that pig production is predominantly managed by economically active adults

Gender distribution revealed that 76.0% of the respondents were male; confirming that swine production in the study area is male dominated. This pattern agrees with findings by Hamzat et al. (2025), who reported that 87.7% of pig farmers in Ibadan Metropolis were male. Likewise, Moses et al. (2024) found that 93.75% of smallholder pig farmers in Imo State were male, suggesting that pig farming in Nigeria remains largely controlled by men because of the labour requirements, capital investment, and management demands associated with the enterprise.

The marital status result showed that 84.0% of the farmers were married. Married farmers are generally more livelihood-oriented and risk conscious because farm income contributes directly to household welfare. Ezeh et al. (2024) similarly reported high proportions of married pig farmers in Kaduna State, explaining that family responsibility encourages farmers to adopt improved production and disease management practices to secure stable income sources.

Household size analysis revealed a mean household size of seven persons, with over half of the respondents having between six and ten household members. Larger household sizes may enhance availability of family labour required for routine sanitation, waste management, and monitoring of farm entry points, which are essential components of farm biosecurity. Nwanta et al. (2011) emphasized that labour availability significantly affects herd-health management practices among pig farmers in Nigeria.

Educational attainment indicated that most farmers possessed formal education at secondary and tertiary levels. Education improves farmers' understanding of disease transmission, hygiene standards, and preventive management practices. Awosanya et al. (2015) established that level of education positively influenced compliance with farm biosecurity protocols among pig farmers in southwestern Nigeria, as educated farmers were more likely to implement recommended disease prevention measures.

Farming experience showed a mean of nine years in swine production, with 59.0% of respondents having between six and ten years of experience. Farming experience enhances farmers' awareness of disease risks and strengthens preventive behaviour based on previous production challenges. Fasina et al. (2012) reported that experienced pig farmers were more likely to invest in preventive biosecurity measures due to the high economic losses associated with disease outbreaks such as African swine fever.

The herd size distribution revealed a mean herd size of 21 pigs, indicating moderately intensive production systems. Increased herd size raises stocking density and consequently the risk of disease transmission within farms. Schembri et al. (2015) noted that farms with larger pig populations require stricter biosecurity protocols to minimize pathogen introduction and spread. Similarly, Wang et al. (2023) observed that herd size significantly influences farmers' disease prevention behaviour and adoption of biosecurity practices.

Annual income from swine production showed a mean income of ₦2,760,000, suggesting that pig farming represents an economically viable enterprise in the study area. Higher farm income enhances farmers' capacity to invest in disinfectants, housing improvement, and veterinary care required for effective biosecurity implementation. Ogunniyi et al. (2011) and Duniya et al. (2013) both reported that profitability in pig production improves farmers' willingness to adopt improved management and disease control practices.

Access to veterinary services was relatively low, with only 26.0% of farmers reporting access to veterinary support. Limited veterinary contact may weaken disease surveillance and reduce adherence to recommended biosecurity practices. Awosanya et al. (2015) similarly identified inadequate veterinary supervision as a major constraint to biosecurity compliance among pig farms in Nigeria.

Membership of farmers' associations showed that 59.0% of respondents belonged to organized farmer groups. Participation in farmer associations enhances access to technical information, training opportunities, and peer learning on disease prevention

practices. Abiola et al. (2015) reported that membership in producer groups improves dissemination of improved swine management practices, thereby strengthening farm health management outcomes.

Table1. Distribution of Swine Farmers According to Socio-economic Characteristics

Age	**Frequency**	**Percentage**	**Mean**
20-30	8	10.0	
31-40	24	30.0	
41-50	35	44.0	
>50	13	16.0	42
Gender			
Male	61	76.0	
Female	19	24.0	
Marital status			
Married	67	84.0	
Single	13	16.0	
Household size			
1-5	31	39.0	
6-10	42	52.0	
>10	7	9.0	7
Highest educational status			
Primary	7	37.0	
Secondary	45	29.0	
Tertiary	28	23.0	
Farming Experience (Swine)			
1-5	12	15.0	
6-10	47	59.0	
>10	21	26.0	9
Herd size (ha)			
1-10	11	14.0	
11-20	24	30.0	
21-30	31	39.0	
>30	14	17.0	21
Annual Income from Swine Production			
500,000 – 1,000,000	3	4.0	
1,000,001 – 1,500,000	8	10.0	
1,500,001 – 2,000,000	11	14.0	
2,000,001 – 2,500,000	15	19.0	
2,500,001 – 3,000,000	17	21.0	
3,000,001 – 3,500,000	13	16.0	
3,500,001 – 4,000,000	8	10.0	
Above 4,000,000	5	6.0	2,760,000
Access to Veterinary Services			
Yes	21	26.0	
NO	59	74.0	
Membership of Farmers' Association			
Yes	47	59.0	
No	33	41.0	-

Source: Field survey, 2026

Awareness of Recommended Biosecurity Practices among Intensive Swine Farmers

The level of awareness of recommended biosecurity practices among intensive swine farmers is presented in Table 2. The results indicate a generally high level of awareness, with a mean awareness index of 0.878. Regular cleaning of pens (0.950), proper disposal of dead pigs and farm waste (0.925), and isolation of sick animals (0.913) recorded the highest awareness levels among respondents, while the use of protective clothing (0.750) recorded the lowest awareness index. The high awareness of hygiene and disease-control practices may be attributed to farmers' exposure to veterinary interventions and disease management campaigns, particularly those associated with African Swine Fever outbreaks (Fasina et al., 2012; Ogundijo et al., 2023). Similar observations were reported by Kouam et al. (2018) and Bedekelabou et al. (2022), who found relatively high awareness of biosecurity measures among livestock farmers. The high overall awareness suggests that most farmers are knowledgeable about essential biosecurity measures required for disease prevention and effective swine production. This implies that factors other than awareness may be responsible for variations in the level of biosecurity compliance among farmers.

Table 2: Awareness of Biosecurity Practices among Intensive Swine Farmers (n = 80)

Biosecurity Practice	A(1)	NA(0)	A/ Score	A/ Index
Quarantine of new pigs	68	12	68	0.850
Disinfection of equipment and clothing	72	8	72	0.900
Restricted visitor access	70	10	70	0.875
Proper disposal of dead pigs and waste	74	6	74	0.925
Regular cleaning of pens	76	4	76	0.950
Use of protective clothing	60	20	60	0.750
Isolation of sick animals	73	7	73	0.913
Controlled feed and water sources	69	11	69	0.863
Total / Mean Awareness Index				0.878

Source: Field survey, 2026

Note: Aware = 1, Not aware = 0

Biosecurity Compliance among Intensive Swine Farmers

The level of compliance with recommended biosecurity practices among intensive swine farmers is presented in Table 3. The results indicate a generally high level of compliance, with a mean biosecurity compliance index (BCI) of 0.779. Isolation of sick animals (BCI = 0.906), proper disposal of dead pigs and farm waste (BCI = 0.888), and restriction of visitor access (BCI = 0.875) recorded the highest levels of compliance among respondents. The high compliance with these disease-control measures may be linked to farmers' experiences with disease outbreaks and increased awareness of livestock health management (Fasina et al., 2012; Ogundijo et al., 2023). Similar findings were reported by Kouam et al. (2018) and Laanen et al. (2013), who observed that sanitation and movement-control measures are among the most commonly adopted biosecurity practices on pig farms. In contrast, the use of protective clothing (BCI = 0.625) and quarantine of newly introduced pigs (BCI = 0.594) recorded the lowest compliance levels. Previous studies have similarly identified these practices as

among the least adopted due to financial and operational constraints (Nantima et al., 2016; Ngom et al., 2024). Overall, the findings suggest that while compliance with major biosecurity measures is high, gaps remain in critical practices aimed at preventing disease introduction into pig farms.

Table 3: Biosecurity Compliance among Intensive Swine Farmers (n = 80)

Biosecurity Practice	FC(2)	PC(1)	NC(0)	Compliance Score BCI
Quarantine of new pigs	23	49	8	95	0.594
Disinfection of equipment and clothing	41	39	0	121	0.756
Restricted visitor access	60	20	0	140	0.875
Proper disposal of dead pigs and waste	62	18	0	142	0.888
Regular cleaning of pens	61	13	6	135	0.844
Use of protective clothing	35	30	15	100	0.625
Isolation of sick animals	65	15	0	145	0.906
Controlled feed and water sources	39	41	0	119	0.744
Total / Mean Compliance Index					0.779

Source: Field survey, 2026

Note: FC=fully complied, PC=partially complied and NC=not complied

Constraints to Biosecurity Compliance among Intensive Swine Farmers

The constraints to biosecurity compliance among intensive swine farmers are presented in Table 4. The major constraints identified by respondents were the high cost of biosecurity materials (56.3%), limited access to veterinary services (47.5%), and lack of technical knowledge (40.0%). These findings suggest that financial, institutional, and technical factors constitute the principal barriers to effective implementation of recommended biosecurity practices. Similar studies have shown that inadequate access to veterinary support, limited farmer training, and the costs associated with implementing biosecurity measures remain important challenges to biosecurity compliance in livestock production systems (Ngom et al., 2024; Rajala et al., 2024). Addressing these challenges through improved veterinary support services, farmer training programmes, and affordable access to biosecurity inputs could enhance compliance and reduce disease risks in swine production.

Table 4: Constraints to Biosecurity Compliance among Intensive Swine Farmers

Constraints to Biosecurity Compliance*	Frequency (n)	Percentage (%)
High cost of biosecurity materials	45	56.3
Limited access to veterinary services	38	47.5
Lack of technical knowledge	32	40.0
Labour shortage	20	25.0
Limited quarantine facilities	18	22.5
Others	5	6.3

Source: Field survey, 2026

*Multiple responses allowed

Determinants of Compliance with Biosecurity practices among Swine farmers in Akwanga LGA, Nasarawa State

The results of the regression analysis presented in Table 5 show that the model was statistically significant ($F = 9.59$; $p < 0.01$), with an adjusted R^2 of 0.499, indicating that 49.9% of the variation in compliance with biosecurity practices was explained by the variables included in the model. Household size ($\beta = 0.944$; $p < 0.01$), education ($\beta = 0.084$; $p < 0.01$), farming experience ($\beta = 0.458$; $p < 0.05$), and biosecurity awareness ($\beta = 6.320$; $p < 0.01$) positively and significantly influenced compliance with biosecurity practices, while herd size ($\beta = -0.024$; $p < 0.10$) had a negative influence. This implies that farmers with larger households, higher educational attainment, greater farming experience, and better awareness of biosecurity measures were more likely to comply with recommended biosecurity practices, whereas compliance tended to decline as herd size increased. Similar findings have been reported by Awosanya et al. (2015), Nantima et al. (2016), Kouam et al. (2018), Bedekelabou et al. (2022), Anh et al. (2023) and Chepkwony et al. (2025), who identified farmer characteristics, knowledge, and awareness as important determinants of biosecurity compliance. Overall, the findings indicate that both farmer characteristics and awareness levels play important roles in determining compliance with biosecurity practices among swine farmers in the study area.

Table 5: Determinants of Compliance with Biosecurity Practices among Swine Farmers in Akwanga Local Government Area, Nasarawa State

Variable	**Coefficient**	**Std. Error**	**T–ratio**	**P–value**
Constant	-1.325	0.493	-2.69	0.008
Age (X_1)	-0.001	0.002	-0.59	0.553
Household size (X_2)	0.944	0.213	4.43	0.000***
Education (X_3)	0.084	0.009	9.34	0.000***
Farming experience (X_4)	0.458	0.189	2.42	0.017**
Herd size (X_5)	-0.024	0.014	-1.75	0.083*
Access to veterinary services (X_6)	0.003	0.010	0.30	0.762
Membership of association (X_7)	0.684	0.892	0.77	0.445
Biosecurity awareness index (X_8)	6.320	1.490	4.23	0.000***
R Square	= 0.520			
Adjusted R Square	= 0.499			
F–Statistic	= 9.59***			
Number of observations	= 80			

***, ** and * denote significance at 1%, 5% and 10% levels respectively.

Conclusion

The study concluded that intensive swine farmers in Akwanga Local Government Area exhibited a high level of compliance with recommended biosecurity practices, as evidenced by a mean biosecurity compliance index of 0.779. Despite this relatively high level of compliance, farmers faced several constraints, notably the high cost of biosecurity materials, limited access to veterinary services, and inadequate technical knowledge. The study further revealed that household size, educational attainment, farming experience, and biosecurity awareness positively influenced compliance with

recommended biosecurity practices, while herd size exerted a negative influence. These findings suggest that both farmer characteristics and institutional factors play important roles in shaping compliance behaviour among intensive swine farmers.

Recommendations

Based on the findings of the study, improving access to veterinary and advisory services should be prioritized to enhance farmers' capacity to implement recommended biosecurity practices effectively. In addition, extension agencies should strengthen farmer training and awareness programmes on practical biosecurity measures and disease prevention to improve compliance and reduce the risk of disease outbreaks in intensive swine production systems.

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