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National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email: japr@napri.gov.ng Url: journal.napri.gov.ng

AFRICAN SWINE FEVER RESURGENCE AND IMPLICATION ON PIG PRODUCTION IN LAGOS AND OGUN STATE, NIGERIA

[1]Boladuro, B. A., [1]Adesehinwa, A. O. K., [1]Saka, J. O., [2]ajayi, E., [1]Idowu, A. B. and [1]Sorunke, A. O.

[1]Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan, Nigeria

[2]Nigerian Institute of Animal Science, Southwest Zonal Office, Ibadan, Nigeria

[*]Corresponding Author: aokadesehinwa@yahoo.com

ABSTRACT

The virulence of African swine fever has remained a major constraint on the growth of swine industry by its virulence and resurgence in Nigeria. Therefore, the contributing factors and the implication of the disease on pig production deserves periodic assessment. This study examined the level of infection, associated losses and contributing factors to ASF on farms in Lagos and Ogun States. Data were from a cross-sectional survey of 201 pig farmers selected by multistage sampling technique. The collected data were subjected to descriptive statistics, partial budget and probit regression analyses to profile the implication of the disease on pig farms. Interactions among farms characterized by visits, sharing of labour, implements and transport facilities were more prominent in Ogun State farms than Lagos while ASF infection and mortality rates were significantly higher in Ogun State (72.6%, 61.6%) than Lagos State (36.1%, 27.1%) respectively. However, there was no significant difference in the average loss attributed to the disease between Ogun and Lagos state farms respectively. Results also showed that increase in age of farmers, farmers' years of experience and distance between pig farmers lowers the probability of occurrence of ASF on farms while increase in household size aggravates it. African swine fever caused huge economic loss and there should be intensified awareness campaign on biosecurity measures for farmers.

Key words: *Swine, Disease outbreak, Biosecurity, Economic loss*

INTRODUCTION

African swine fever (ASF) has been reported as a virulent disease of pigs that originated in Africa and has been reported in other continents from the 1950s (Cwynar*et al*., 2019). The virulence and cyclic nature of African swine fever (ASF) disease has been a major hindrance to sustainable growth of the Nigerian pig industry. Its virulence is rooted in high mortality in infected animals of all ages. ASF is a notifiable hemorrhagic disease caused by an *Iridovirus* (*Asfarviridae*) (Beltrán-Alcrudo, 2017). Its natural hosts in Africa are wild members of the pig family where it is transmitted by soft ticks and does not cause clinical disease (Penrith and Vosloo, 2009; Sanchez-Vizcaino *et al*., 2015). Persistence of the virus in the Nigerian pig population has been linked with presence of persistently infected and carrier sero-positive pigs on farms, uncontrolled breeding programmes, pig product movements, traders and middlemen operations and especially inadequate biosecurity measures (Olugasa and Ijagbone, 2007).

According to Fasina *et al*. (2011), field observations and opinion polls of some 95 smallholder pig farmers in parts of Nigeria revealed a huge deficiency in the understanding and implementation of basic concepts of biosecurity at farm level.

Previous studies suggested that ASF outbreaks, even if they are small, could cause substantial economic losses to pig farming in the affected areas (Halasa *et al*., 2016; Lyytikäinen *et al*., 2015). It is important to

explore the potential consequences of a major epidemic in Nigeria and to consider potential ramifications as it spreads. Lagos and Ogun States of Southwest Nigeria had in the past witnessed high rate of spread of the disease due to presence of cluster pig farms and transmission across the border respectively. After the outbreak of the previous years, another outbreak of ASF was reported in 2020 with Lagos and Ogun States as one of the worst hit states in South West Nigeria. Such occurrence if not adequately addressed can undermine further investment and the sustainable growth of the pig industry.

This challenge has been largely recognized following previous incidences of the disease with recommended control measures emphasizing intensified efforts on biosecurity and creation of effective multi-stakeholder early warning systems. Effectiveness of these approaches points to the importance of the production environment, capabilities of farmers to adopt recommended practices and existence of motivation to report threats of the disease promptly. The dominance of pig farming by smallholder farmers with their known incapability towards adoption of recommended in turn makes the influence of farm and farmer-specific attributes on incidence and intensity of the disease appealing to investigation, especially when resurgence has been reported. This study therefore investigates the production environment for pig production, incidence of ASF, associated losses and contributing factors to the resurgence of the disease in Ogun and Lagos State of Nigeria.

Methodology

Data were collected through a socio-economic study designed for the collection of cross-sectional data from pig farms selected by multi-stage sampling techniques. Southwest Nigeria comprise of 6 states (Ekiti, Lagos, Ogun, Ondo, Osun and Oyo). The region is noted for production of livestock such as poultry, pig, goat, sheep and cattle supported by large concentration of commercial farms and livestock feed mills. Lagos and Ogun States are two prominent pig production states and shared history of incidence of occurrence of ASF in the past. Under the National Agricultural Research Project, each state is divided into Agricultural Development Programme (ADP) zones, blocks and cells usually adopted as enumeration units (EUs) for farm surveys.

In this study, two prominent pig production zones and blocks (Local Government Areas) were selected in each of the states. Five villages noted for pig production were also selected purposively and lastly pig farmers were randomly selected in each of the villages based on the list of pig farmers obtained from the Extension Office in each of the Agricultural Development Programme (ADP) in each of the zones. The pre-determined sample size was put of 250 pig farmers as constrained by available resources. However, sample size in each state is determined by probability proportionate to size of farming households in each of the states.

$$S_{si} = \frac{n_i}{N_t}.S_t \quad .. \quad . \quad . \quad (1)$$

Where:

S_{si} = Sample Size for State i (i = 1, 2 for Ogun and Lagos State respectively)

n_i = Population of Farming Households in state i.

N_t = Total of Population of farming households in the two states

S_t = pre-determined sample size for the study (250)

Lagos state has 558,440 farming households while Ogun State has 360,000 farming households (South West REFILS Report, 2018). Consequently, 152 farmers were interviewed in Lagos State while 98 pig farmers were interviewed in Lagos State. However, 201 of the questionnaires certified as containing adequate information of core values to the objectives of the study were analysed for the study.

Data were collected through personal interview conducted with the aid of

questionnaires designed to elicit information on the farm and farmer specific attributes of pig production in the study areas. Data were collected on stock size and stock composition, occurrence of ASF disease on the farms and the associated loses in terms of stock of animals and the monetary values. Data were also collected on demographic attributes of the farmers such as sex, age, years of formal education, years of experience in pig farming, access to alternative income among others. Data were analyzed using descriptive statistics while Probit regression analysis was estimated to identify the contributing factors to ASF incidence on pig farms.

Empirical studies on incidence of diseases on farms (Ahmad and Battese, 1997, Oluyole and Lawal, 2008) have captured the influence of farmer and farm specific attributes on disease incidence on farms. Some of the models considered incidence of disease as a binary option of occurrence and otherwise thereby making binary choice models amenable to such studies. This study therefore employed Probit Model to identify the drivers of ASF incidence on pig farms. Following Ahmad and Battese, (1997) the Probit model is of the form

$$Y_i^* = \beta X_i + \varepsilon_i \quad . \quad . \quad . (2)$$

$$Y_i = \begin{cases} 1 \; if \; Y_i^* \geq 0 \\ 0 \; if \; Y_i^* \leq 0 \end{cases}$$

Where

Y_i = Observed binary dependent variable which takes the value of 1 for incidence of ASF disease on farm ith and 0 for non-incidence of on farm.

Y_i^* = is the latent variable that depicts incidence of ASF in the ith farm

X_i = a row vector value of farm and farmer specific variables as regressors for the ith farm

β = a k x 1 vector of parameters to be estimated

ε_i = an error term assumed to have standard normal distribution.

Hence, the probability function is of the form

$Y_{i1}^*(X) = \beta_i X_i + \varepsilon_{ij}$ for ASF incidence, and

$Y_{i0}^*(X) = \beta_i X_i + \varepsilon_{ij}$ for otherwise (3)

Hence, the probability function bounds the incidence of ASF as assuming the function of the ith farm and farmer specific attributes. Hence, a pig farm will experience incidence of ASF disease only if the probability of occurrence is given by

$$P(1) = P(Y_{i1} > Y_{i0}) \quad . \quad .. \quad (4)$$

Hence,

$$P(1) = P(\beta_1 X_i + \varepsilon_{i1}) > P(\beta_0 X_0 + \varepsilon_{i0}) . (5)$$

$$P(1) = P(\varepsilon_{10} - \varepsilon_{i1} < \beta_1 Xi - \beta_0 Xi) \quad . \quad . (6)$$

$$P(1) = P(\varepsilon_i < \beta_i X_i) \quad . \quad . \quad . \quad . (7)$$

$$P(1) = \theta(\beta X_i) \quad . \quad . \quad . \quad . \quad . (8)$$

Where θ is a cumulative normal distribution function of ε for a probit model. Hence, a farm's probability of experiencing ASF is given by

$$\theta_f(\beta X_i) = \int_{-\infty}^{\beta X_i} \frac{1}{\sqrt{2\pi}} \exp\left(\frac{-t^2}{2}\right) dt \quad . \quad . (9)$$

Considering the incidence of ASF disease on pig farms as influenced by socio-economic characteristics of farmers, the empirical model of the probit form as adapted from the foregoing, is given by

$$Z_i = \beta_0 + \sum_{i=1}^{n} \beta_i X_i, \varepsilon \quad . \quad . \quad . \quad (10)$$

The empirical model in its explicit form is given by

$$Z_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots \beta_n X_{ni} + \varepsilon_i \quad . \quad . \quad . \quad . \quad (11)$$

where Zi is equal to 1 for incidence of ASF disease and 0, if otherwise, β_0 Is a constant term, β_i are parameters to be estimated and X_i are explanatory variables namely; Sex, age of farmer, household size, farm experience (years), experience in pig farming (years), farming as major occupation, possession of alternative income source, years of formal education, distance between pig farms (km), stock size of pigs in the farm and location of farm in urban centres (1, 0), boar stock size, sow stock size, growers stock size and weaners stock size which are expected to determine the incidence of ASF in the farms or otherwise.

RESULTS AND DISCUSSION

The demographic distribution shows the characteristic dominance of male in pig farming as an agricultural enterprise across the two states with most of the farms established in rural communities mostly on lands acquired by rent or outright purchase (Fig. 1). Majority of the farmers are predominantly engaged in farming as main occupation (Table 1a) with average years of experience 11.3 and 10.2 years for Lagos and Ogun States respectively (Table 1b). Farmers in Ogun state are relatively younger than the pig farmers in Lagos State while there was no significant difference in their years of formal education. Average household size was significantly higher in Ogun State (6) than Lagos State (5).

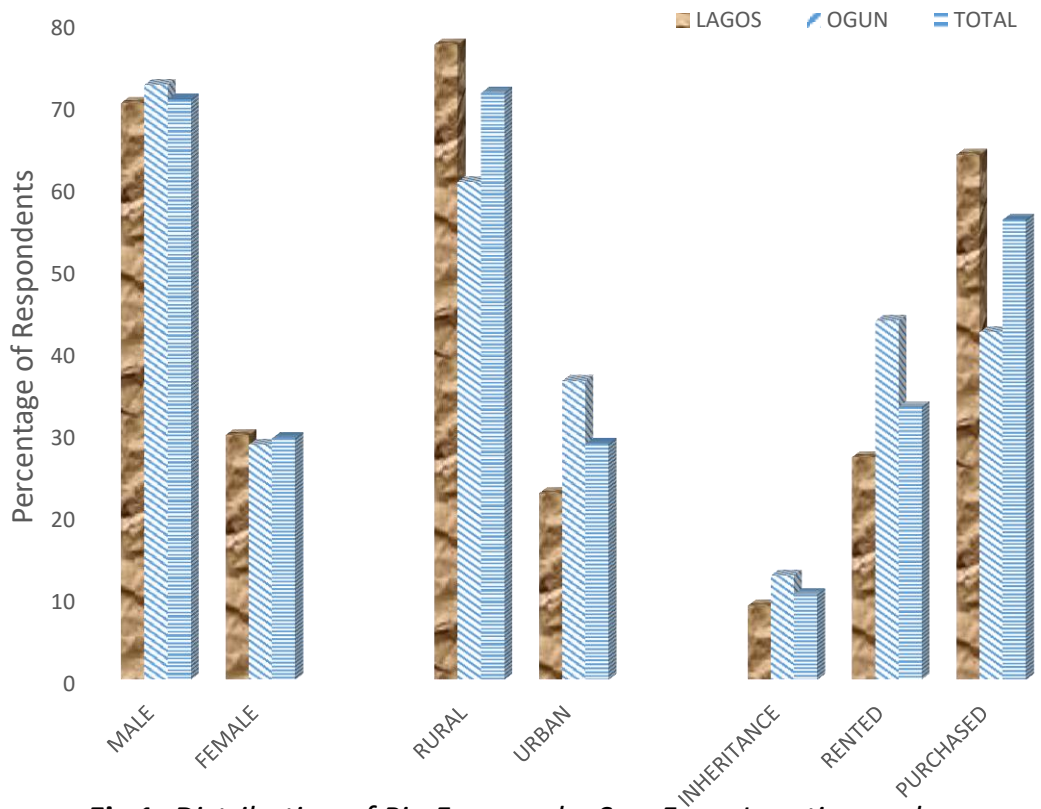


Fig 1: *Distribution of Pig Farmers by Sex, Farm Location and Source of farmland*

Table 1(a): Demographic Characteristic of Pig Farmers

	Lagos	Ogun	Total
Major Occupation			
Artisan	08 (6.5)	01 (1.3)	09 (4.5)
Entrepreneur	06 (4.8)	01 (1.3)	07 (3.5)
Farming	104 (83.9)	69 (89.6)	173 (86.1)
Professional	01 (0.8)	03 (3.9)	04 (2.0)
Retiree		01 (1.3)	01 (0.5)
Salary Earner	05 (4.0)	02 (2.6)	07 (3.5)

Values in parentheses are percentages

Table 1(b): Demographic Characteristics of Pig Farmers

	Lagos	Ogun	Pooled
Age of Farmer	53.14±9.95	48.85± 11.61	51.50 ±10.51**
Years of Experience in Pig farming	11.33±7.02	10.22±6.29	10.92 ±6.78
Years of Education	12.62±4.54	12.86 ± 6.12	12.70 ± 5.08
Household Size	5.19±1.29	6.15 ± 2.94	5.52 ±2.06***

The results in Table 2 shows that there was no significant difference in distances among pig farms in Lagos and Ogun States. Average distance among pig farms was 1.04Km and 0.91km for Lagos and Ogun State respectively. Similarly, there was no significant difference in distance among farms irrespective of method of acquisition of land for pig farms or whether such farms were located in rural or urban areas. A distance of less than 2 km was observed between farms irrespective of their location (urban and rural) and mode of acquisition. In addition, the results in Table 3 shows that mode of interaction among farms included but not limited to sharing of implements, visitors, transportation of farm products and labour. The commonest mode of interaction among pig farms were sharing of implements (25%), visit by fellow farmers (21.6%) and transportation of animals (21.6%). The results also shows that interaction among pig farms in the various ways were more common in Ogun State than Lagos State.

Table 2: Distance between Pig Farms (Km) by State, Land Acquisition Method and Farm Location

State	Average Distance (Km)	Land Acquisition Method	Average Distance (km)	Farm Location	Average Distance (km)
Lagos	1.04 (4.89)	Inherited	1.47 (1.46)	Urban Area	0.43 (1.52)
Ogun	0.91 (2.07)	Purchased	1.36 (6.67)	Rural Area	1.23 (4.82)
		Rented	0.75 (2.24)		
F-Stat	0.04	F-Stat	0.46	F-Stat	0.95

Values in parentheses are in percentage

Table 3: Type of Frequent Interaction among Farms

Kind of interaction	Lagos	Ogun	Total
Visit by labourers	14 (13.0)	20 (28.2)	34 (19.0)
Visit by customers	01 (0.8)	21 (31.8)	22 (11.9)
Visit by farmer groups	01 (1.1)	32 (52.5)	33 (21.6)
Exchange of implements	03 (3.6)	33 (54.1)	36 (25.0)
Transport of farm products	07 (7.8)	27 (40.9)	34 (21.7)
Transport of labour	03 (4.2)	25 (40.3)	28 (20.9)

Values in parentheses are percentages

Figure 2 showed the common diseases experienced on pig farms and these include but not limited to diarrhea, foot rot and ASF. Although the results suggests that African swine fever (ASF) was not a disease of common occurrence as other diseases such as diarrhea (37.8%) and foot rot (15%) among the pig farms, the outbreak could be dreadful due to its virulence. Prevalence among farms in years of occurrence are usually widespread among farms. African swine fever was recorded in 61.6% of the pig farms with larger prevalence (77.6%) recorded among pig farms in Ogun State as shown in Table 4. It is also worthy of attention that out of these affected farmers, 65.6% of them experienced African swine fever on their farms for the first time in 2020 (Table 4). In year 2007, the outbreak affected both Lagos and Ogun States but in year 2011, Ogun State was not affected while both States were affected in year 2020.

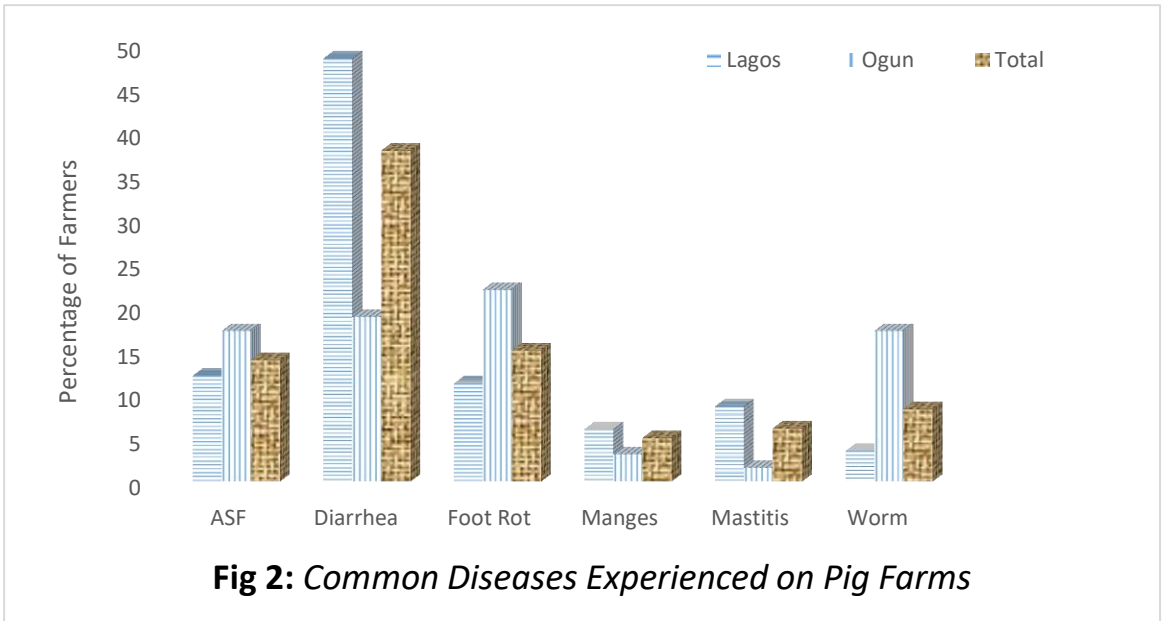


Fig 2: *Common Diseases Experienced on Pig Farms*

Table 4: ASF Incidence on Pig Farms

	Lagos	Ogun	Total
Occurrence	60 (51.3)	59 (77.6)	119 (61.6)
Year of 1st occurrence			
2007	01 (2.2)	02 (3.6)	03 (3.0)
2011	17 (37.8)		17 (16.8)
2020	22 (48.9)	44 (78.6)	66 (65.4)

Values in parentheses are percentages

About 50.1% of pig stocked was infected with ASF while 40.3% mortality was recorded among the pig farms. Average stock size lost to the disease was 66 pigs with greater infection rate and mortality observed among pig farms in Ogun State than Lagos State (Table 5). The economic analysis revealed average value of one million, one hundred and thirty-two thousand, four hundred and sixteen naira (₦1,132,416) worth of animals was lost per farm with no significant difference in average value of animals lost to disease by farms in Ogun and Lagos States (Table 6).

The results of probit analysis in Table 7 shows that four of the specified variables (age, household size, experience in pig farming and distance between pig farms are significant contributors to ASF incidence in pig farms. The likelihood ratio chi-square of 91.23 which is significant at $P<0.01$ attest to the joint significance of the specified probit model.

Table 5: Effect of ASF Disease on Pig Production

	Average Total Stock Size	Stock Infected	Stock size Lost	Infection Rate (%)	Mortality Rate (%)
Lagos	173.03 (198.03)	78.72 (129.89)	55.02 (100.96)	36.06 (28.35)	27.10 (29.91)
Ogun	204.15 (215.18)	120.75 (124.64)	83.18 (94.07)	72.62 (26.82)	61.63 (62.40)
Total	184.95 (204.80)	94.82 (129.22)	65.81 (99.09)	50.07 (32.94)	40.33 (48.09)
F-Stat	1.10	5.13**	3.89**	82.27***	27.76***

Table 6: Average Values of Animals lost to ASF

	Average Value of Losses (N)	Standard Deviation
Lagos	1,035,375.40	2,043,324.90
Ogun	1,288,689.10	2,229,167.20
Total	1,132,416.00	2,114,483.2
F-Stat	0.68	

Table 7: Factors influencing incidence of ASF Disease on Pig Farms

Variable	Coefficient	Standard error
Sex	0.184	0.296
Age	-0.059	0.016***
Household size	0.036	-0.123**
Farm experience	-0.020	0.045
Experience in Pig Farming	-0.171	0.049***
Farming as Major occupation	-0.264	0.438
Alternative income Sources	-0.034	0.315
Years of Education	-0.038	0.025
Distance between pig farms	-1.74	0.397***
Stock size	-0.002	0.002
Location in Urban centre	-0.042	0.031
LR Chi Sq	91.23***	
Pseudo R-square	0.411	
Log Likelihood	-65.45	

***Significant at P<0.01, **Significant at P<0.05

The demographic distribution depicts a population that is within the productive years, educated and favourably disposed to pig farming as the main source of income. Having spent more than ten years in the enterprise, the farmers are expected to have garnered enough experience over time to enhance their capabilities in analyzing situations for risk-reducing and productivity enhancing management decisions. These are also expected to drive adoption of improved technologies and biosecurity measures in pig production. Previous studies (Abdullah and Sammah, 2013, Pierpaoli *et al* 2013, Challa and Tilahun, 2014, Mishra *et al*, 2018) have underscored the importance of age and education to effective management decision towards adoption of improved technologies.

ASF is a virus disease whose control is basically built upon abilities of farms to prevent occurrence and spread through adequate biosecurity measures. The understanding of the rudiments of biosecurity is expected to be enhanced by farmers' level of formal education Pig production has been shown to be a vocation of the educated in the study area as also shown by Adebowale *et al* (2020). However, access to land for pig farming in the wake of growing urbanization has remained a challenge. Consequently, creation of cluster pig farms have assumed prominence in the swine industry with challenges relating ability of farms to maintain safe distances from each other.

Establishment of cluster farms at short distances to each other facilitates possible close interaction among farms through sharing of labour, equipment and even feed stuff. Such interactions undermines the effectiveness of biosecurity measures and subsequently, aggravates spread of diseases and associated losses. The implication of this has been shown in this study with the incidence of the disease being lower in Lagos State where level of interaction among farmers was lower compared to Ogun State. This also suggests the level of awareness of biosecurity measures among Ogun State

farmers and calls for urgent need to educate these farmers on biosecurity measures in order to prevent losses associated with disease transmission. Breaches in biosecurity measures and poor farming practices characterized by sharing of equipment, external sourcing of animals, means of transport and slaughtering of animal on the farm have been widely reported by studies (Awosanya *et al*, 2015, Dione *et al*, 2015, Nantima *et al*, 2015, Bellini *et al*, 2021, Bergmann *et al*, 2022) as prominent risk factors in ASF prevalence and huge economic loses in pig farms.

The high mortality rate and the associated loss in monetary values attributed to ASF by the farmers corroborates the findings of previous studies (Lyytikäinen *et al*., 2015 and Halasa*et al*., 2016) on the impact of the disease on investment in pig production. The direct cost of the disease arising from income loss due to mortality of animals requires that efficient warning system be put in place against the viral disease while efforts should be intensified on sensitization on biosecurity.

Fasina *et al* (2011) also reported huge deficiency in the understanding and implementation of basic concepts of biosecurity at farm level among smallholder pig farmers in parts of Nigeria. The results of the empirical model in this study have shown that the probability of occurrence of ASF on farm is significantly heightened by increase in household size of farmers while increase in age, experience of farmers in pig production and distance between pig farms limits the likelihood of recording ASF in pig farms. In smallholder agriculture, large household size are possible sources of family labour for farm work and when such are engaged effectively on farm operation, it is expected to enhance productivity. However, dependence on family labour can limit the effectiveness of biosecurity on pig farms especially when such members attend to other farms as source of income, thereby increasing the risk of spreading the causative virus to other farms. However, farmers attributes such as increase in age, years of experience enhances managerial capabilities of farmers in taking appropriate decision regarding biosecurity and disease prevention on pig farms. The efficacy of such efforts is also enhanced when farms are located at adequate distance to each other rather than the prevailing situation that increases the vulnerability of pig farms found in clusters.

CONCLUSION AND RECOMMENDATION

This study examined the pattern of ASF infection and the associated losses in Lagos and Ogun States of South West Nigeria. It also determines the influence of farm and farmer specific attributes on the occurrence of ASF in pig farms in the States. The outbreak was severe in the study locations with enormous losses in stock and value. The production practices of farmers in Ogun State characterized by lower distance between farms, visits of pens by labourers, customers and other farmers, sharing of labour, implements and transport facilities by farms points to gaps in adherence to biosecurity measures by the farmers. This might have been responsible for to high ASF incidence and mortality rate in the State compared to Lagos State. It is also a pointer to the challenges associated with establishment of cluster pig farms which aggravates vulnerability to the constituent farms to these risk factors in the absence of adequate biosecurity measures. Therefore, multi-stakeholder sensitization programmes should be intensified to educate farmers on appropriate biosecurity measures to combat disease outbreak especially, African swine fever. Such measures should include maintenance of adequate distance between farms, limiting of interaction characterized by sharing of labour and materials by farms among other measures. Farmers should however be adequately involved in the planning, implementation, monitoring and evaluation of such programmes to entrench ownership of the initiatives. Such approach is capable of strengthening sustainability for effectiveness, increased productivity and sustainable growth of the swine industry.

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