

---

## REPRODUCTIVE AND FERTILITY PARAMETERS OF PIGS REARED IN ENUGU STATE, NIGERIA

---

<sup>1</sup>NJOGA, Ugochinyere Juliet, <sup>2</sup>ILO, Stanley Uzochukwu, <sup>3</sup>UGWU, Patience Chinasa, <sup>4,5</sup>AJIBO, Festus Ejike, <sup>3</sup>BERNARD, Nwabueze Sunday, <sup>1</sup>ONWUKA, Osita Sunday and <sup>5</sup>NJOGA, Emmanuel Okechukwu

<sup>1</sup>Department of Veterinary Obstetrics and Reproductive Diseases, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria.

<sup>1</sup>Department of Veterinary Obstetrics and Reproductive Diseases, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria.

<sup>2</sup>Department of Animal Science, Faculty of Agriculture, University of Nigeria, Nsukka, Enugu State, Nigeria.

<sup>3</sup>Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria.

<sup>4</sup>Department of Animal Health and Production, Enugu State Polytechnic, Iwollo, Enugu State, Nigeria.

<sup>5</sup>Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria.

**Corresponding Author:** Njoga, U. J. Department of Veterinary Obstetrics and Reproductive Diseases, Faculty of Veterinary Medicine, University of Nigeria, Nsukka. **Email:** [ugochinyere.njoga@unn.edu.ng](mailto:ugochinyere.njoga@unn.edu.ng) **Phone:** +234 7035386831

*Received* December 07, 2020; *Revised* January 05, 2021; *Accepted* January 06, 2021

---

### ABSTRACT

*Pigs are highly prolific but mismanagement practices can hamper their reproducibility. Consequently, reproductive and fertility parameters of pigs reared in 86 randomly selected piggeries in Enugu State, Nigeria were studied using structured questionnaire. Farmers' responses were validated from their farm records, where available. Majority of the farms stocked < 100 pigs (59.3 %). Intensive husbandry system (91.9 %) predominated in the piggeries. Open mating, hand breeding and artificial insemination were the breeding methods practiced in 52, 40.4 and 7.7 % of the farms respectively. Inter-farrowing intervals were five months and  $\geq$  seven months in 11.6 and 18.6 % of the piggeries. The numbers of piglets born alive per sow per year were: < 5 piglets (14 %), 5 – 10 piglets (36 %), 11 – 15 piglets (24 %) and  $\geq$  15 piglets (26 %). Correspondingly, the numbers of piglets weaned per sow per year were: < 5 piglets (26 %), 5 – 10 piglets (40 %), 11 – 15 piglets (24 %) and  $\geq$  15 piglets (10 %). Only 2 % of the piggeries attained production target of weaning  $\geq$  20 piglets per sow per year. Major causes of pre-weaning piglet mortalities were scouring (52.3 %) and maternal overlay (16.3 %). The findings suggest that prolificacy and productivity of pigs farmed in Enugu State is suboptimum. This warrants provision of veterinary extension services, training on modern pig production methods and genetic improvement of breeding stocks to boost the reproductive and fertility parameters and hence productivity in pig farming enterprises in the State.*

**Keywords:** Fertility indices, Inter-farrowing interval, Piglet mortality, Pig production, Reproductive parameters

---

## INTRODUCTION

The domestic pig, *Sus scrofa domesticus* [Linnaeus 1758], is perhaps among the first farm animals to have been domesticated. Domestication of pigs started in the Asian continent from wild ancestral pig (*Sus scrofa*) around 8500 BC (Evin *et al.*, 2017). Pigs are reared in most parts of the world principally for provision of pork, biomedical raw materials (insulin) and manure (Ajibo *et al.*, 2020). Additionally, the popularity of pigs as pets in western cultures has increased in recent times, as many pig lovers now keep small-sized pigs (mini or micro pigs) as companion animals in their homes (Marissa, 2014). A typical example of pig kept as pet is the miniature "Kunekune" breed cherished due to its personality, temperament and ease of management (Marissa, 2014).

Nigeria is a major pig producer in the West African Sub-region, producing about nine of the 14 million pigs reared in the Sub-region (Ajibo *et al.*, 2020). In Nigeria, pig production activities are concentrated in the South, particularly in the Southeast, due to religious and cultural proscription to pig production and pork consumption in some parts of the North (Nwanta *et al.*, 2011). As a result, pig production is a popular agribusiness in Enugu State, as crop farmers, civil servants and traders usually engage in pig farming for additional income. With about 10 million Nigeria households in rural and semi-urban areas involved in pig farming (World Bank, 2017), swine production may have not just supported the economic well-being of these families but have also improved the animal proteins deficit in the country. The shortfall in the provision of animal protein in Nigeria may have been occasioned by low rate of food-animal production in relation to human population growth rate (Nkwocha *et al.*, 2010).

Fortunately, pigs have the potentials to become the leading animal protein-deficient gap filler in Nigeria due to their polytocous and multiparous natures. Additionally, pig farming can also be a major employer of labour in the livestock subsector and therefore contribute significantly to job creation, poverty alleviation

and crime reduction in developing countries. The high feed conversion efficiency, early maturing nature, short gestation length and ability to thrive under sub-optimal tropical conditions confer pig comparative advantages over other food-producing animals (Pierozan *et al.*, 2016) and lend credence to the aforementioned potentials. Furthermore, pig rearing has the advantage of economy of space in contrast to ruminant productions. Also, the marketability of pork and pork products tends to warranty profitability and timely returns on any investment in the swine industry (Nwanta *et al.*, 2011).

Despite these potentials and comparative advantages over other food-producing animals, the productivity of pigs reared in Enugu State seems to be at its lowest ebbs as slaughter pigs in the State are still being sourced from neighbouring States (Ajibo *et al.*, 2020). The reason for the low productivity in piggeries in the State has largely remained elusive or speculative. However, this may not be unconnected with the fertility and reproductive indices of the pigs. In pig production, fertility refers to the viability, virility and functionality of the reproductive organs in mature male (boar) and female (gilt or sow) pigs in order to engage in breeding activities that will climax in conception. In the female, fertility also includes the ability of the gravid sow/gilt to carry the resultant pregnancy to term and farrow successfully with minimal assistance and without major complication (Ate and Oyedipe, 2011).

On the other hand, reproductivity in pigs is determined solely by the number of piglets weaned per sow per year (Abonyi *et al.*, 2012). The number can be affected by certain parameters such as litter size, number of farrowing per sow per year and number of piglets farrowed alive per sow per year (Abah *et al.*, 2019). Others parameters are percentage pre-weaning mortality, inter-farrowing interval, age at first farrowing and weaning to conception interval (Sinha *et al.*, 2015; Koketsu *et al.*, 2017). Since proliferation efficacy is paramount to the productivity, profitability and sustainability of pig farming enterprise, this study determined the fertility and reproductive

parameters of pigs reared in Enugu State, in order to recommend management measures to boost pig production.

## MATERIALS AND METHODS

**Study Area:** The study was carried out in Enugu State, located in the Southeast geopolitical zone of Nigeria. Enugu State is situated on latitude 6° 51' 24°N, longitude 7° 23' 45°E and elevation of 1,810 ft. above sea level. The State has a population of about five million people (NPC, 2006), relative humidity of 14 %, annual rainfall ranges of 1520 to 2030 millimeters and temperature ranges of 20 to 41° C (Nwanta *et al.*, 2011). Moreover, the study area experiences rainy/wet and hot/dry seasons each year. Civil service, trading, and crop farming are the major occupations in the State. However, animal agriculture, particular pig farming is widely practiced as a supplementary occupation to augment income.

**Selection of Pig Farms Surveyed:** From a sampling frame of 328 piggeries, 120 piggeries were purposively selected for the survey based on the willingness of the farm owners to partake in the study and accessibility of the farms. On final analysis however, only 86 piggeries selected from 9 local governments areas – Nsukka (13), Udenu (10), Igboeze South (8), Igboeze North (10), Enugu East (12), Isi-Uzo (8), Igbo-Etiti (8), Enugu North (8) and Enugu South (9) - were included in the study due to inconsistency in data collected from 24 of the 120 farms surveyed.

Majority of the farms surveyed were household/backyard piggeries. Few established piggeries surveyed are: Animal Science Pig Farm (University of Nigeria, Nsukka), Veterinary Teaching Farm - piggery section (University of Nigeria Nsukka), God First Piggery (Enugu), Sabugo Farms (Agbani), Alpha Piggery (Nike-Enugu), Obumneme Piggery (Ugwogo-Nike), Hero Agro Consult and Farms (Nsukka) and Chukwudi Nweze Farms (Nsukka).

**Data Collection:** A structured closed-ended questionnaire was prepared and pretested on 12 piggeries at Awka, Anambra State in order to

detect and correct possible errors that may arise in the actual survey. The questionnaire was subjected to face and content validation as described by Bolarinwa (2015). Data on the body condition score (BCS) of the pigs were collected after physical examination as described by Chikwanha *et al.* (2007). The study lasted for 8 weeks (August to September, 2020). Thereafter, the validated questionnaire was distributed (one per farm) to the farm owners/managers who were knowledgeable in the daily activities of the farms. Questions on the questionnaire border on the socio-demographics of the pig farmers, farm management practices and reproductive and fertility indices of pigs reared. The effects of breed on the reproductive and fertility performances were not prioritized as all the pigs surveyed were crossbreed. The researchers adopted face-to-face interview format during the survey and verified information advanced by the respondents from their farm records (where available). For respondents who are limited in their ability to read or understand the English language, the content of the questionnaire was communicated in vernacular (Igbo) and their responses recorded accordingly.

**Data Analysis:** Completed copies of the questionnaires were retrieved for collation and analysis of the data. Subsequently, the collated data were converted to percentages and proportions, and presented in tables and graphs.

## RESULTS

**Socio-demographics of Pig Farmers:** Majority (79.0 %, 68/86) of the piggery owners/managers surveyed were male. Most (59.3 %, 51/86) of the farmers were small-scale-farmers, having flock size of less than 100 pigs. On farming experience, 51.2 % (44/86), 37.2 % (32/86) and 15.1 % (13/86) had less than 10, 10 – 20 and more than 20 years farming experiences respectively (Table 1). Only 25.6 % (22/86) of the pig farmers/managers had training on modern pig production methods. On educational levels attained by the farmers, 3.5 % had no formal education, while 40.7 % had tertiary education.

**Table 1: Socio-demographics of pig farmers surveyed in Enugu State, Nigeria**

Information Required	Proportion of Respondents (%)
<b>Sex</b>	
Male	68(79.0)
Female	18(21.0)
<b>Flock size</b>	
< 100	51(59.3)
100-500	24(27.9)
> 500	11(12.8)
<b>Farming experience (years)</b>	
< 10	44(51.2)
10 – 20	32(37.2)
> 20	10(11.6)
<b>Training on modern pig production method</b>	
Yes	22(25.6)
No	64(74.4)
<b>Highest educational level attained</b>	
No formal education	3(3.5)
Primary	21(24.4)
Secondary	27(31.4)
Tertiary	35(40.7)

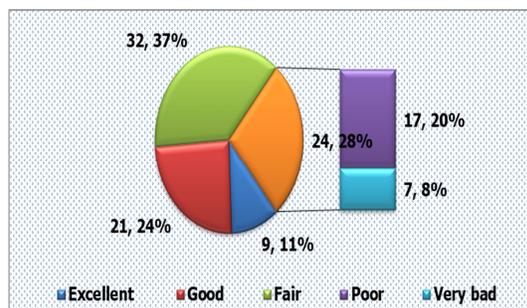
**Farm Management Practices in the Piggeries:** Intensive farm management system was the predominant production system practiced in 91.9 % (79/86) of the pig farms visited. Similarly, majority of the piggeries produced their own feed on-farm, from locally available feed stuffs (65.3 %) even though kitchen wastes and left-over food were fed to supplement daily feed rations (Table 2).

**Table 2: Farm management practices adopted in piggeries surveyed in Enugu State, Nigeria**

Information Required	Number of Piggeries (%)
<b>Husbandry systems</b>	
Intensive	79(91.9)
Semi-intensive	7(8.1)
<b>Source of feed*</b>	
Self-compounded feed	81(65.3)
Kitchen waste	43(34.7)
Commercial feed	Nil
<b>Availability of veterinary services</b>	
Yes	54(62.8)
No	28(32.6)
No response	4(4.6)

\*Some farms sourced feed from more than one sources

Sixty three percent of the farms had access to veterinary services provided by veterinarians and other animal health workers. Summary of results on the average body condition scores of the pigs at various piggeries are presented in Figure 1.



**Figure 1: Body condition score estimates of pigs reared in piggeries surveyed in Enugu State, Nigeria**

Farm hygiene and other biosecurity practices were generally poor. Vaccination against endemic swine diseases, including brucellosis, was not done in any of the piggeries surveyed. Only 33.7 and 12.8 %, of the farms screened their pens with net and had functional foot dip at pen entrances respectively. Similarly, daily removal of dungs and disinfection of feed/water troughs were done in only 29.1 and 18.6 % of the piggeries respectively. Restriction of visitors and enforcement of unidirectional movement within the piggery were not practiced in 90.7 and 94.2 % of the farms.

**Reproductive Parameters of Pigs:** The average age of sows at puberty/first services was 7 – 8 months in 33.7 % (29/68) of the piggeries (Table 3).

**Table 3: Reproductive indices of pigs reared in 86 piggeries surveyed in Enugu State, Nigeria**

Reproductive Indices	Number of Piggeries (%)
<b>Average age of sow at puberty/first service</b>	
6 months or less	25(29.1)
7 – 8 months	29(33.7)
9 – 10 months	21(24.4)
Above 10 months	11(12.8)
<b>Breeding method employed*</b>	
Open mating (boar runs with the female)	54(51.9)
Hand breeding (supervised natural mating)	42(40.4)
Artificial insemination	8(7.7)
<b>Weaning to service interval</b>	
Less than 10 days	4(4.7)
10-20 days	16(18.6)
21-30 days	22(25.6)
More than 30 days	39(45.3)
No response	5(5.8)

Number of farrowing in the last one year	
None	9(10.5)
One	37(43)
Two	34(39.5)
No response	6(7)
Common reproductive defects/conditions*	
Scrotal hernia	43(39.8)
Abortion	19(17.6)
Lameness	31(28.7)
Others	15(13.9)

\*Respondents advanced more than one response

Open mating (boar runs with the female) was the breeding method practiced in 52.0 % (54/86) of the farms. Similarly, hand breeding (supervised natural mating) and artificial insemination breeding techniques were done in 40.4 and 7.7 % of the farms respectively. Scrotal hernia (39.8 %), abortion (17.6 %) and lameness (28.7 %) were common reproductive defects/conditions in the piggeries surveyed.

Common causes of pre-weaning piglet mortalities in the farms were scouring (52.3 %), maternal overlay (16.3 %), cannibalisms (8.2 %), starvation due to agalactia (10.5 %) and unknown causes (12.8 %). Results on other reproductive parameters such as weaning to service interval and number of farrowing per year are presented in Table 3. Data on the average number of piglets farrowed per sow and number of piglets weaned per sow are shown in Figures 2 and 3 respectively.

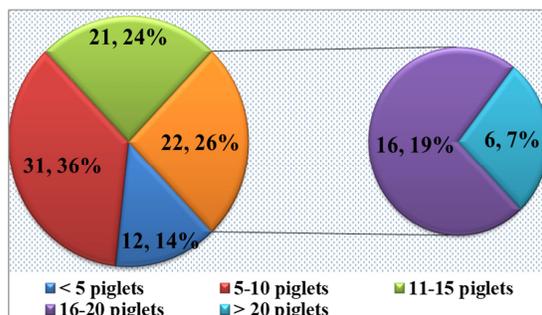


Figure 2: Average number of piglets farrowed alive per sow per year in piggeries surveyed in Enugu State, Nigeria

Only 2.0 % of the piggeries attained the standard production target of weaning  $\geq$  20 piglets per sow per year. Sows in 21 of the 35 piggeries whose owners/managers attained tertiary educational level had average farrowing frequency of twice yearly (Figure 4).

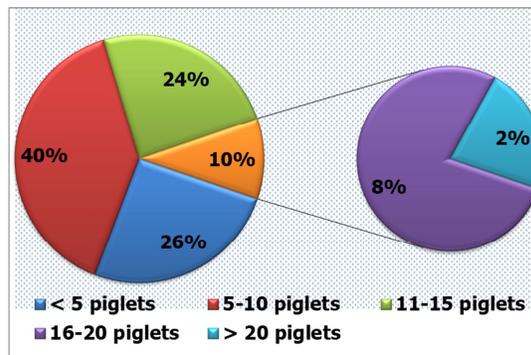


Figure 3: Average number of piglets weaned per sow per year in piggeries surveyed in Enugu State, Nigeria

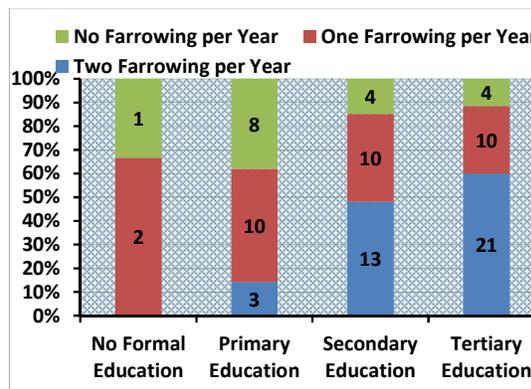


Figure 4: Effect of educational levels of pig farmers on the average number of farrowing per year in the piggeries surveyed in Enugu State, Nigeria

**Fertility Indices of Pigs:** Average gestational length was normal (114 days) in 47.7 % of the farms (Table 4).

Table 4: Fertility indices of pigs reared in piggeries surveyed in Enugu State, Nigeria

Fertility Indices	Number of Piggeries (%)
<b>Average gestational length in days</b>	
113 and below	12(14)
114	41(47.7)
115 and above	15(17.4)
Unknown	18(20.9)
<b>Inter-farrowing interval</b>	
$\leq$ 5 months	10(11.6)
6 months	22(25.6)
7 months	38(44.2)
> 7 months	16(18.6)
<b>Post weaning return to estrus</b>	
3 – 5 days	14(16.3)
6 – 7 days	19(22.1)
Above 7 days	21(24.4)
Unknown	32(37.2)
<b>Average number of services per pregnancy</b>	

One	8(9.3)
Two	14(16.3)
Three	22(25.6)
More than three	28(32.6)
Not known	14(16.3)
<b>Major estrus signs observed*</b>	
Standing on hand pressure or when boar mounts	29(22)
Swollen, reddened vulva	38(28.8)
Vocalization/grunting	13(9.8)
Hyperactivity(restlessness)	10(7.6)
Sticky, viscous secretion of vulva.	42(31.8)

\*Respondents advanced more than one response

Inter-farrowing intervals were reported to be five, six and seven months in 11.6 %, 25.6 % and 44.2 % of the piggeries respectively. However, in 18.6 % of the farms the inter-farrowing interval was more than seven months. Post-weaning return to estrous was 3 – 5 days in 16.3 % (14/86) of the farms while average number of services per pregnancy was three in 22.6 % of the piggeries (Table 4). The major estrous signs observed were standing on hand pressure or when boar mounts (22.0 %), swollen/reddened vulva (28.8 %), vocalization/grunting (9.8 %), discharge of sticky/viscous secretion at the vulva (31.8 %) and hyperactivity (7.6 %).

## DISCUSSION

The goal in pig farming is to produce and wean maximum number of piglets per sow per year. Ideally, the number of piglets weaned per sow per year has become the yardstick for measurement of fertility and reproducibility in the swine industry (Koketsu *et al.*, 2017). To this end, it is expected that each sow in the piggery should farrow at least two times and wean 20 to 30 piglets per year (Koketsu *et al.*, 2017). Cognizant of this, the average number of piglets weaned per sow per year in all the farms surveyed fall short of this standard as only two of the 86 farms weaned up to 20 piglets per sow per year.

The average number of piglets weaned per sow in this study was lower than that reported by Sinha *et al.* (2015). The cause of the low number of piglets weaned may be multifactorial. Firstly, it may be due to increased inter-farrowing intervals (Ate and Oyedipe,

2011). For optimum productivity, the inter-farrowing interval should not be more than five months in order to guarantee a minimum of two parturitions per year or five farrowing in two years (Koketsu *et al.*, 2017). Considering that only 11.6 % of the farms reported inter-farrowing interval of five months or less, it is most probable that increased inter-farrowing interval decreased the number of farrowing per year and hence the number of piglets weaned per sow per year.

Secondly, the type of breeding method employed can also affect reproducibility and hence productivity in pig farming. Artificial insemination is the preferred breeding method in pig production as it decreases the chances of breeding estrous sows/gilts with infertile boar; which in turn decreases the possibility of repeat breeder syndrome or conception failure post breeding (Ate and Oyedipe, 2011). However, only 7.7 % of the farms carried out artificial insemination, probably due to lack of facilities and technical know-how needed for the technique. On the contrary, the open mating and hand breeding methods widely employed in the farms surveyed may enhance conception failure as these methods do not prevent infertile boars from breeding (Nauta *et al.*, 2001). The situation may be worsened when the dominant boar is infertile, as it may not allow subordinate fertile males to breed (Nauta *et al.*, 2001; Horback and Parsons, 2018). The resultant effect may be decreased conception rate in the piggery and therefore reduced numbers of farrowing and piglets weaned per sow per year as seen in this study.

Be that as it may, open mating and hand breeding methods have the advantage of breeding almost all sows/gilts on heat, as boars can naturally detect female pigs on heat. Additionally, these methods aid sexual maturation in the female via a complex mechanism of pheromone interaction called boar effect (Umesiobi, 2010). This is because physical or fence-line boar contact with sows/gilts induces and increases the frequency of plasma surge in luteinizing hormone (LH), leading to pre-ovulatory LH surge that will culminate in ovulation (Umesiobi, 2010). However, it is important to note that boar effect

produces the best result when there is complete physical contact i.e. when sows/gilts are exposed to the sight, sound, touch and smell of a mature boar (Althouse, 2015). Boar effect is also important for full expression of estrus and reduction of weaning-to-estrus interval (Umesiobi, 2010).

The third and most important likely cause for the low number of piglets weaned per sow per year is high pre-weaning piglet mortality (Abonyi *et al.*, 2012). Although the reported number of piglets born alive per sow was acceptable, it appears that majority of these piglets died before weaning and hence the low number of piglets weaned per sow. Scouring was the commonest cause of piglet mortality probably due to high microbial feed contamination during the on-farm feed formulation (Abonyi *et al.*, 2012). Piglets due to their immunological naivety may readily succumb to gastroenteritis following the consumption of feed contaminated with microbial pathogens (Abonyi and Njoga, 2020). As a result, diarrhea or dysentery (depending on the infecting organism) and the associated fluid and electrolyte losses in the piglets will ultimately cause pre-weaning piglet mortalities. Aside microbial pathogens, mismanagement of pregnant sows during farrowing may lead to maternal overlay and pre-weaning piglet mortalities (Marchant *et al.*, 2000) and this should therefore be avoided. The poor biosecurity practices and lack of veterinary care observed in some of the farms surveyed could also explain the high pre-weaning piglet mortality that contributed in the low number of piglets weaned.

For optimum productivity and profitability in pig production, there is need to enhance the fecundity of breeding sows in order to increase the number of piglets born alive per sow per year (Abah *et al.*, 2019). In doing this special attention must be given to breed and breeding season. Although pigs are not seasonal breeders, the fertility and prolificacy of sows seems to be higher during the rainy/wet seasons in tropical settings (Hagan and Etim, 2019). Also, certain pig breeds or crossbreeds seem to do better than others in terms of litter size, litter weight and nursing capabilities

(Hagan and Etim, 2019). This is why farmers should pay particular attention to the number of teats during selection of breeding stock even though litter size naturally increases with parity levels (Ate and Oyedipe, 2011). In sows litter size seems to vary directly proportional to the number of teats (Abonyi *et al.*, 2012). The findings of Drickamer *et al.* (1999) indicated that teat number in breeding sows correlated with both litter size and male litter sex ratio; as greater number of teats on the dam increased the number of piglets farrowed and lowered the proportion of males in the litter.

In the attempt to increase litter size or number of piglets born alive per sow, there should be commensurate effort to improve on the health and nutritional management of the pigs because the number of grunts and low weight litters increases with increasing litter size (Rekwot *et al.*, 2001; Motaleb *et al.*, 2014; Kouamo *et al.*, 2015). This may warrant formulation of special rations for pregnant sows and nursing dams; and also creep/foster feeding for grunts or low weight piglets. Additionally, enlightenment programs, training on modern pig breeding and production methods; as well as provision of veterinary extension services or subsidized veterinary care to pig farmers in rural areas could help boost productivity of pigs in Enugu State, Nigeria.

**Conclusion:** The reproductive performance of pigs reared in Enugu State, Nigeria as indexed by the number of piglets weaned per sow per year was sub-optimal. High piglet mortality due to diseases, limited veterinary care and poor management practices were to be blamed for the low piglet yield per sow. Provision of veterinary extension services, training on modern pig farming methods and use of genetically improved breeding stocks could enhance prolificacy and productivity of swine in the study area.

#### ACKNOWLEDGEMENTS

The authors are grateful to the farmers who volunteered information and allowed us access into their farms/farm records.

## REFERENCES

- ABAH, K. O., ITODO, J. I., UBAH, S. A. and SHETTIMA, I. (2019). Reproductive performance of pigs raised by intensive management system in Abuja, Nigeria. *Veterinary World*, 12(2): 305 – 308.
- ABONYI, F. O. and NJOGA, E. O. (2020). Prevalence and determinants of gastrointestinal parasite infection in intensively managed pigs in Nsukka agricultural zone, Southeast, Nigeria. *Journal of Parasitic Diseases*, 44(1): 31 – 39.
- ABONYI, F. O., OMEH C. V. O. and MACHEBE, N. S (2012). Neonatal mortality of pigs in Nsukka, Southeast Nigeria. *African Journal of Biotechnology*, 11(68): 13228 – 13234.
- AJIBO, F. E., NJOGA, E. O., AZOR, N., IDIKA, K. I. and NWANTA, J. A. (2020). Epidemiology of infections with zoonotic pig parasites in Enugu State, Nigeria. *Veterinary Parasitology: Regional Studies and Reports*, 20: 100397. <https://doi.org/10.1016/j.vprsr.2020.10.0397>
- ALTHOUSE, G. C. (2015). *Sow and Gilt Management*. Merck Vet Manual. <https://www.merckvetmanual.com/management-and-nutrition/management-of-reproduction-pigs/sow-and-gilt-management> Accessed December 4, 2020.
- ATE, I. U. and OYEDIPE, E. O. (2011). Sow reproductive performance in institutional herds in Benue State, Nigeria. *Journal of Reproduction and Infertility*, 2(2): 24 – 31.
- BOLARINWA, O. A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Nigerian Postgraduate Medical Journal*, 22(4): 195 – 201.
- CHIKWANHA, O. C., HALIMANI, T. E., CHIMONYO, M., DZAMA, K. and BHEBHE, E. (2007). Seasonal changes in body condition scores of pigs and chemical composition of pig feed resources in a semi-arid smallholder farming area of Zimbabwe. *African Journal of Agricultural Research*, 2(9): 468 – 474
- DRICKAMER, L. C., ROSENTHAL, T. L. and ARTHUR, R. D. (1999). Factors affecting the number of teats in pigs. *Journal of Reproduction and Fertility*, 115(1): 97 – 100.
- EVIN, A., DOBNEY, K. and CUCCHI, T. (2017). A history of pig domestication: new ways of exploring a complex process. Pages 39 – 48. In: MELLETTI, M. (Ed.). *Ecology, Conservation and Management of Wild Pigs and Peccaries*. Cambridge University Press, United Kingdom.
- HAGAN, J. K. and ETIM, N. N. (2019). The effects of breed, season and parity on the reproductive performance of pigs reared under hot and humid environments. *Tropical Animal Health and Production*, 51(2): 411 – 418.
- HORBACK, K. and PARSONS, T. (2018). Swine life history. Pages 1 – 66. In: VONK, J. and SHACKELFORD, T. (Eds.). *Encyclopedia of Animal Cognition and Behavior*. Springer, Cham. <https://doi.org/10.1007/978-3-319-47829-61413-1>
- KOKETSU, Y., TANI, S. and IIDA, R. (2017). Factors for improving reproductive performance of sows and herd productivity in commercial breeding herds. *Porcine Health Management*, 3: 1. <https://doi.org/10.1186/s40813-016-0049-7>
- KOUAMO, J., TANKOU, W. T., ZOLI, A. P., BAH, G. S. and ONGLA, A. N. (2015). Assessment of reproductive and growth performances of pig breeds in the peri-urban area of Douala (Equatorial Zone). *Open Veterinary Journal*, 5(1): 64 – 70.
- MARCHANT, J. N., RUDD, A. R., MENDEL, M. T., BROOM, D. M., MEREDITH, M. J., CORNING, S. and SIMMINS, P. H. (2000). Timing and causes of piglet mortality in alternative and conventional farrowing systems. *Veterinary Record*, 147(8): 209 – 214.
- MARISSA, C. (2014). *The Big Problem with Mini Pigs*. National Geographic News.

- <https://www.nationalgeographic.com/news/2014/10/140930-animals-culture-science-miniature-pigs-breeders-sanctuaries/> Accessed November 24, 2020.
- MOTALEB, M. A., CHOWDHURY, M. K., ISLAM, M. A., AHMED, J. U. and BHUIYAN, M. M. U. (2014). Reproductive parameters of native sows in selected area of Bangladesh. *Bangladesh Journal of Veterinary Medicine*, 12(2): 211 – 215.
- NAUTA, W. J., BAARS T., GROEN A. F., VEERKAMP R. F. and ROEP, D. (2001). *Animal Breeding in Organic Farming: Discussion Paper*. Louis Bolk Institute, Hoofdstraat 24, 3872 LA Driebergen, The Netherlands. [https://www.researchgate.net/publication/28680071\\_Animal\\_breeding\\_in\\_organic\\_farming\\_discussion\\_paper](https://www.researchgate.net/publication/28680071_Animal_breeding_in_organic_farming_discussion_paper) Accessed January 1, 2021.
- NKWOCHA, G. A., ANUKAM, K. U., OGUOMA, O. N. and NKWOCHA, V. I. (2010). Animal agriculture as panacea for increased protein intake in Nigeria. *Animal Production Research*, 6(3): 242 – 246.
- NPC (2006). *Population and Housing Census, Population Distribution by States, LGAs and Senatorial Districts*. National Population Commission (NPC), Abuja, Nigeria. Priority Table, Volume III, 1 – 64. <http://catalog.ihnsn.org/index.php/catalog/3340/download/48521> Accessed September 1, 2020.
- NWANTA, J. A., SHOYINKA, S. V., CHAH, K. F., ONUNKWO, J. I., ONYENWE, I. W., EZE, J. I., IHEAGWAM, C. N., NJOGA, E. O., ONYEMA, I., OGBU, K. I. and MBEGBU, E. C. (2011). Production characteristics, disease prevalence, and herd-health management of pigs in Southeast Nigeria. *Journal of Swine Health and Production*, 19(6): 331 – 339.
- PIEROZAN, C. R., AGOSTINI, P. D. S., GASA, J., NOVAIS, A. K., DIAS, C. P., SANTOS, R. S. K., PEREIRA JR, M., NAGI, J. G., ALVES, J. B. and SILVA, C. A. (2016). Factors affecting the daily feed intake and feed conversion ratio of pigs in grow-finishing units: the case of a company. *Porcine Health Management*, 2(1): 7. <https://doi.org/10.1186/s40813-016-0023-4>
- REKWOT, P. I., JEGEDE, J. O., EHOCHÉ, O. W. and TEGBE, T. B. (2001). Reproductive performance in smallholder piggeries in northern Nigeria. *Tropical Agriculture*, 78(2): 130 – 133.
- SINHA, R. C., AI-MARUF, A., KUNDU, A. K., RAHMAN, A., ISLAM, T. and MAMUN, A. A. (2015). Determination of reproductive parameters of sows at rural areas of Bangladesh. *Journal of Advanced Veterinary and Animal Research*, 2(1): 74 – 79.
- UMESIOBI, D. O. (2010). Boar effects and their relations to fertility and litter size in sows. *South African Journal of Animal Science*, 40(5): 471 – 475.
- WORLD BANK (2017). *Better Life Farming – Unlocking the Potentials of Smallholder Farmers to Reach Sustainable Development Goals*. The World Bank, Washington DC, USA. [http://liveworldbank.org/better-life-farming?cid=ECR\\_FB\\_worldbank\\_EN\\_EXTP\\_SM2018-betterlifefarming\\_PIX](http://liveworldbank.org/better-life-farming?cid=ECR_FB_worldbank_EN_EXTP_SM2018-betterlifefarming_PIX) Accessed October 22, 2019.



This article and articles in *Animal Research International* are Freely Distributed Online and Licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) (CC-BY 4.0) <https://creativecommons.org/licenses/by/4.0/>