

Sow Reproductive Performance in Institutional Herds in Benue State, Nigeria

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Abstract: This study was carried out to determine the reproductive performance of sows in institutional swine herds which serve as model herds in Benue state, central Nigeria. Herd records on 185 sows that littered 3,995 piglets from three herds were used for the analysis of reproductive and production performance. Management practices including reproductive management, herd structure, breeds of sows, animal types, reproductive and production indices such as age at first farrowing (AFF), conception rate (CR), farrowing interval (FI), number of litter per sow per year (NLPSPY), litter size at birth (LSAB) and at weaning (LSAW), litter weight at birth (LWAB) and at weaning (LWAW), number of pigs reared per sow per year (NSRPSPY), stillbirth (SB), preweaning piglet mortality (PWPM) and sow longevity (SL) were assessed. The performance parameters obtained were AFF (14.93±0.24), CR (>90%), FI (23±6.81), NLPSPY (2.0), LSAB (10.75 ± 0.56), LWAW (8.1±0.47), LWAW (6.76±0.15), NPRPSPY (17.03±1.21), SB (9.16%), PWPM (25.22%) and SL (5- 6 years). It was concluded that though most of these values were within the global range values some were below the target performance values recommended for optimal sow productivity.

Key words: Reproductive performance % Sows % Herd % Nigeria

INTRODUCTION

The pig is considered to be a highly prolific species with a high ovulation rate and if mated at the right moment, the sow also holds a very high probability of pregnancy [1]. It is a highly productive animal compared with other farm animals [2].

Reproductive performance of the sow herd is the key factor, if not the major factor, in controlling the efficiency of swine production [3, 4] and considered economically important to the swine industry [5]. It is measured primarily by the number of living pigs at birth or by the total farrowing or weaning weight of pigs produced by the dam within one year [2]. Low levels of reproductive performance may not only result in low profit per sow, but will also limit attempts to improve the herd genetically [4].

There are several measures of reproductive performance including farrowing rate and litter size at birth and fertility index. Other parameters used include, pounds of pork/sow/yr and non - productive sow days [6]. The goal of reproductive performance is to have 2.0 litters per female annually with an average of 8.0 pigs per litter at weaning, that is, a total of 16 pigs weaned per year for each female maintained in the herd [5].

Benue state is considered as the 'Food Basket' of the Nigerian nation. Although most of the agriculture being practiced by the majority of the populace is crop based, there is also subsistence livestock agriculture such as cattle, pigs, small ruminants and poultry alongside [7]. Pigs occupy a special place in the sociocultural life of most parts of Tiv area of the state, especially with regard to marriage rites. Also, pork (pig meat) is highly cherished among the Tiv people and is often considered second to an 'unknown first'. At relaxation joints, pork prepared as 'pepper - roasted meat' plays some significant role. There are therefore enormous potentials for pig production in the state. However, accessibility and/or affordability of pigs and its products for these situations are most of the times difficult due to the limited production of pigs. In addition, other factors such as occasional outbreaks of diseases including African swine fever [8] are known to decimate even the limited pig population in Nigeria. There are several smallholder swine herds in the state that offer erratic supply of pigs and its products in the state. The productivity of these smallholder swine herds as is generally for any livestock enterprise in Nigeria may be considered to be low and limited by several constraints [9, 10]. The Benue state government has embarked on an

effort to revive pig production in the state. The state is to empower 50 farmers per senatorial zone annually with improved breed [7] as one of the strategies for poverty alleviation under its Benue Economic Empowerment Development Strategy (BENSEEDS) scheme in collaboration with Iowa State University in USA.

Although few reports exist on the reproductive performance of smallholder piggeries in Benue state [4, 11], there is currently a paucity of information on the reproductive performance of sows in institutional herds in Benue state. For the effort of the Benue State Government to achieve the above desired goals, a comprehensive knowledge of the performance levels of sows is required. This research therefore was carried out to determine the current performance of sows in the existing institutional swine herds.

MATERIALS AND METHODS

Study Area and People: The study was carried out in Gboko, Makurdi and Otukpo LGAs of Benue state. Benue state of Nigeria lies on longitude 6° 35" to 10 E and latitude 6°30"N to 8°10" of the equator. It has a population of 2,780,359 and a total land area of 30955 square kilometers [7]. The state has 23 local government areas with its headquarters at Makurdi. The State derives its name from River Benue, the second largest river in the country and it is the most prominent geographical feature in the State. At present, Benue State has twenty-three local governments, 14 in the Tiv speaking area and 9 in the Idoma speaking area. The Tiv people are the majority and spread to other states like Nassarawa, Taraba, Plateau and Cross-River, followed by the Idoma, then the Igede people and other smaller groups. Benue State lies in the middle of the country and thus falls within the middle Belt States and shares boundaries with Nassarawa to the North; Taraba to the East; Cross River to the South; Enugu to the South -West and Kogi to the East. The State also shares a common boundary with the Republic of Cameroon on the southeast and has a population of about 2,780,389 and occupies a landmass of 30,955 square kilometers [7].

Benue State has been rightly christened the "Food Basket of the Nation" because of its rich agricultural potentials [7], which include yams, rice, beans, cassava, sweet potatoes, maize, Soya beans, sorghum and cocoyams. It has vast and fertile landmass, which is tilled by the over 70% of its population that treasures agriculture as the bedrock of its livelihood. The River

Benue equally presents great potentials for a viable fishing industry and dry season farming through irrigation.

Benue State experiences a typical tropical climate with two distinct seasons, the wet or rainy season and the dry season. The rainy season lasts from April to October with annual rainfall in the range of 150 - 180 mm. The dry season begins in November and ends in March. Most of the people in the State are farmers while inhabitants of the riverine areas engage in fishing as their primary or important secondary occupations. Benue State is acclaimed the nation's food basket because of its diverse rich agricultural produce which includes yams, rice, beans, cassava, soya beans, benniseed, maize, sorghum, millet, tomatoes and a lot of fruits. Poultry, goat, sheep, pigs and cattle are the major domestic animals kept.

Location of Herds: The study was carried out on three herds designated as A, B and C, which were located in Gboko, Makurdi and Otukpo respectively in Benue state. All the herds were institutional herds. These herds were chosen for this pilot study because of their ease of accessibility and anticipated cooperation.

Herd Description and Management

Herd A: This herd was established in 1963. The herd has a landmass of 100 M². It is located at Gboko, the headquarters of Gboko LGA. The farm also has 35 cattle, 60 goats, 34 sheep, 200 poultry and 120 rabbits. The current herd size was nil as all the pigs were sold out due to a threatened African swine fever outbreak. However, from available records, the breed in the herd was Large White x Hampshire cross. There were 5 staffs who are in charge of the farm, consisting of full time and part time staff. The housing was made up of a standard building with roof and individual room for sows and cement floor. The breeding system was natural, with a male to female ratio of 1:10. Gilts were bred on - farm. The pigs were fed twice a day, with starter, grower, finisher, forages/roughages and home - made rations. The gilts and boars are fed 3 kg feed per day and lactating sows are fed 3 kg while piglets are fed *ad libitum*. Concentrates were given to all categories in unspecified amounts occasionally. The source of water was a borehole and water was provided *ad libitum*. The sows in gestation were wet cleaned with cleaning additives. Chemical disinfection was employed on the farm. All the production areas (gestation, lactation, weaners and fatteners) were disinfected once daily in the morning. Disinfection was affected by the cost of

chemicals as well as absence of water when the borehole broke down. No vaccinations were provided the pigs. Treatment against endoparasites was given routinely to all pigs, sows thrice, weaned pigs twice a year, gilts once and boars twice a year respectively. Pregnancy diagnosis was done using the boar. There was no batch farrowing. The farmer sometimes supervised farrowing. Piglets were not weighed after birth. Colostrum ingestion by the piglets is ensured to have taken place. Iron injection (iron dextran) was given to the piglets during the first three days of life. No hormonal treatment was given to the pigs.

Herd B: This herd was established in 1985 and has a current herd size of 32 pigs. It is located in the North Core area of the University of Agriculture, Makurdi, in Makurdi town. The farm also has 45 cattle, 12 goats, 32 sheep, 670 poultry and 37 rabbits. The current herd size was 53 pig consisting of 10 sows, 2 boars, 22 gilts and 19 piglets. The breeds present were large white, Land Race, Hampshire and Large White x Land Race x Hampshire crosses respectively. There were 4 staffs in charge of the farm on full time basis. The housing was made up of a standard building with roof and individual room for sows and cement floor. The breeding system was natural, with a male to female ratio of 1:10. Gilts were bred on - farm and some were bought from other piggeries. The husbandry system was intensive. The pigs were fed twice a day, with starter, grower, finisher, forages/roughages and home - made rations. The gilts and boars were fed 3 kg feed per day and lactating sows are fed 3 kg while piglets are fed *ad libitum*. Pigs were fed individually twice daily at 2 kg of feed per head per day. Concentrates (soyabeans, maize and dried brewer's grain) were given to all categories of pigs in unspecified amounts occasionally. Feed supplementation is given (*Tridax*, *Prucubences*, *Amaratius*) to sows, pregnant sows and lactating sows. The source of water was from the well and tap and water was provided *ad libitum*. The sows in gestation and lactation are dry cleaned with cleaning additives. Chemical disinfection was employed on the farm. All the production areas (gestation, lactation, weaners and fatteners) were disinfected once daily in the morning. Disinfection was however depended on the availability of chemicals. No vaccinations were provided to the pigs. Treatment against endoparasites was given routinely to all pigs, sows once or twice/year, weaned pigs once a year and gilts twice/yr. Routine pregnancy diagnosis is not. There is no batch farrowing. Farrowing was not routinely supervised but sometimes it took place in the presence of the

farmer/herdsman. Sows are washed before being introduced into the farrowing pen. Piglets are weighed after birth. Colostrum ingestion by the piglets was ensured to have taken place. Oral injection of iron was given to the piglet. There was no hormonal treatment given to the pigs.

Herd C: This herd was established in 1974 and has a current herd size of 32 pigs. It is located at Otukpo the headquarters of the LGA. The current herd size was 53 pig consisting of 10 sows, 2 boars, 22 gilts and 19 piglets. The breeds present were Large White, Land Race, Hampshire and Large White x Land Race x Hampshire crosses respectively. There were 15 staffs in charge of the farm on full time basis. The housing was made up of a standard building with roof and individual room for sows and cement floor. The breeding system was natural, with a male to female ratio of 1:5. Gilts were bred on - farm and some were bought from other piggeries. Weaning was done at 52 days. The husbandry system was intensive. The pigs were fed twice a day, the feed consisting of maize, groundnut cake/soyabean cake, maize/wheat offal and rice offal. The gilts and boars were fed 2 kg feed per day and lactating sows were fed 2.5 kg while piglets were fed *ad libitum*. Pigs were fed individually and in groups. No supplementation was given. The source of water was from the well and tap and water was provided *ad libitum*. The sows in gestation and lactation are dry cleaned with cleaning additives. Chemical disinfection was employed on the farm twice a month. All the production areas (gestation, lactation, weaners and fatteners) were disinfected once daily in the morning. No vaccinations were provided the pigs. Treatment against endoparasites was given routinely to all pigs, sows once or twice/year, weaned pigs once a year and gilts twice a year. Routine pregnancy diagnosis was not done and there was no batch farrowing. There was no farrowing supervision policy *per se* but farrowing was sometimes in the presence of the farmer/herdsman especially during the daytime. The farrowing pens were washed before sows were introduced into them. Piglets were weighed after birth. Colostrum ingestion by the piglets was ensured to have taken place. Iron injection was given to the piglets. There was no hormonal treatment given to the pigs.

Animals: All the adult female pigs that farrowed (sows) at least once and their piglets in the study herds whose records were available were used for the study. Ear tags properly identified them.

Study Design: The study was made up of two phases - retrospective and prospective phases.

Retrospective Study: A structured questionnaire covering information on herd such as age of herd, manpower in charge, land area, herd size and structure, management practices, production indices, past medical conditions of the herd, nature of veterinary services and care, disease prevention, acquisition of new animals, was distributed to the managers of the respective swine herds who completed them. In addition, personal interviews and interactions with the managers and herdsmen were held on certain aspects that were not adequately covered by them in the course of completing the questionnaires.

Prospective Survey: During this study phase which lasted over a four months period (September, 2009 to December, 2009), regular visits were made to the herds with the view of monitoring all the sows and piglets and recording of health conditions especially reproductive and udder conditions of pregnant, parturient and post parturient sows and piglets. Information including nature of parturitions, obstetrical problems, piglet performance and mortality, maternal performance, how the reproductive and udder disorders were managed and the challenges faced in the management of the conditions were to be recorded.

Parameters Studied and Methods Used

Reproduction Performance Indices of Sows: The performance and productivity indices of 185 sows in terms of age at first farrowing, farrowing interval, conception

rate, litter size at birth and at weaning, litter weight at birth and at weaning, number of farrowings per sow per year, number of pigs reared per sow per year, sow longevity, piglet mortality and stillbirth, were obtained from herd records using the structured questionnaire. Sows in herd A were not involved in the computation of these indices because they lacked records on them.

Data and Statistical Analyses: Mean values plus standard error of means were obtained for AFF, FI, LS and LW at overall, herd and breed levels respectively. Similarly, conception rate, stillbirth and piglet mortality at these levels were expressed as percentages. T - Test was used to compare the means of AFF, FI, LS and LW between herds B and C, which had reasonable sizes and p value of <0.05 was considered as significant. Analysis of variance (one way) was used to test for significant differences in the performance indices among the predominant breeds (LW, LWX and HM) and p value at <0.05 was considered significant. The results were expressed in the form of appropriate descriptive statistics and prevalence rates among herds and breeds were subjected to Chi square test for statistical significance difference at p value of 5%. All data were analyzed using Graphpad Prism 4.

RESULTS

Reproductive Performance and Productivity of Sows:

Table 4.6 shows the reproductive performance and productivity indices of sows in the three herds. The age at first farrowing (13 months), farrowing interval

Table 1: Reproductive performance and production indices of sows in institutional herds

Parameter	Value			
	Herd A	Herd B	Herd C	Total
Age at first farrowing (AFF) months	NA	12	14	13
Conception rate (%)	>90	>90	>90	>90
Farrowing interval (FI) days	NA	164	120	142
Litter size (average)				
At Birth	NA	11	9	7.5
At Weaning	NA	7.65	8	6.7
Litter weight				
At Birth	NA	1.09	1.2	1.02
At Weaning	NA	6.18	8.5	6.40
No. of farrowings/sow/year	NA	2	2	2.0
No. of pigs reared/sow/per year	NA	15	16	15
Sow longevity (SL)(Years)	NA	NA	5 - 6	5 - 6
Piglet mortality at weaning (%)	NA	34.16	26.52	25.22
Stillbirth (%)	NA	13.33	5.00	9.16

(142 days), piglet mortality (25.22%) and stillbirth (9.56%) and conception rate was above 90% in all herds. There were wide disparities in these performance indices among the various herds. The farrowing interval and stillbirth values were higher in herd B than in herd C. The average litter size and weight at birth and at weaning were low compared to values for same breeds in temperate countries. The number of farrowings per sow per year and number of pigs reared per sow per year were however close to the annual target for values for these parameters. Records were not available for most of these parameters in herd A. Only herd C had information on the average length of productive life (LPL), which was found to be between 5 and 7 years depending on the productivity of the individual sow.

DISCUSSION

Globally, the literature is replete with information on the performance indices of sows. However, few published reports are considered to exist on sow performance in tropical countries [12]. Although most of the reproductive performance and productivity indices of sows obtained in this study fell within values reported in the literature, stillbirths, abortion and piglet mortality values were not considered optimal for efficient swine productivity.

Different figures exist on AFF in several countries of the globe [413, 14, 4, 16, 17]. The age at first farrowing of 390 days (13 months) obtained in this study falls within the global range values of 278 - 925 (mean 547.65) days [15-17]. It is lower than the value of 15 months reported for smallholder piggery farms in Benue state [4]. The difference may be attributed to the supposedly better management in institutional herds. Sows in herd B were obtained from herd C, but they had a higher AFF than their counterparts in herd C (164 vs. 120 days). The difference is probably as a result of variations in the management practices. The average conception rate (CR) of above 90% obtained for all herds in this study falls within the value that is generally considered acceptable and optimal [18]. The farrowing interval (FI) obtained in this study is higher than the global mean value of 159.06 days [16], but lower than the figure of 249 days has been reported for Mexican sows [16]. It however compares well with the results by [19] for smallholder piggeries in Benue state, in which, most FI were within the range of 5 to 8 months (average 7.50 months). The high values of FI in this study may not be unconnected with the inadequate management practices in these herds. The number of farrowings per sow per year of 2 obtained in this study falls below the target performance value of 2.4 reported [18] and is slightly below the 22.1 to 2.2 reported for

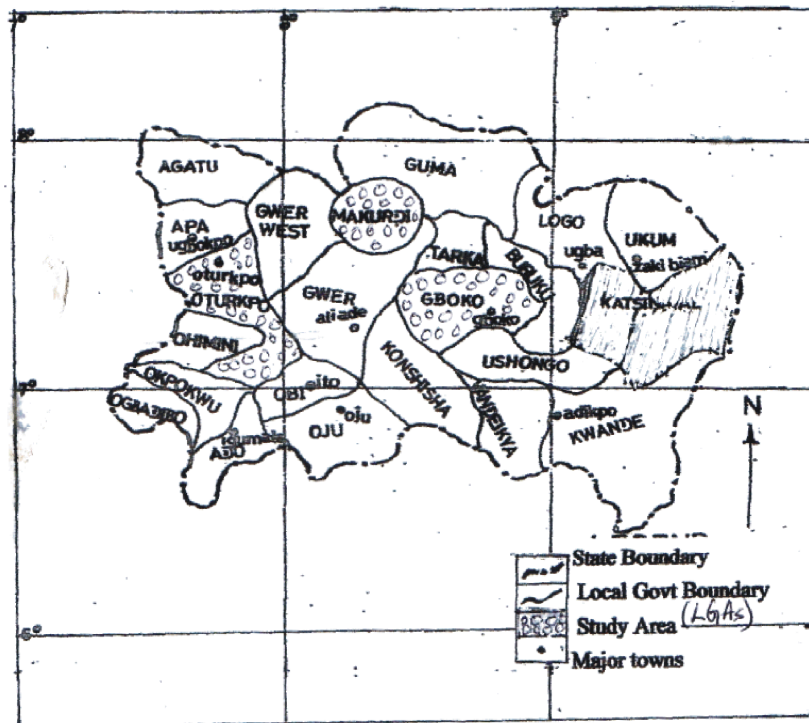


Fig. 2.2: Map of Benue state showing local government areas (dots - where study herds are located).

the Nordic countries [20]. It is considered that the value of this parameter of less than 2.4 requires intervention measures [18]. The number of pigs reared per sow per year obtained in this study compares well with the figure of 10.5 considered as an excellent performance [21]. The values of these parameters obtained in this study are all below the average values indicated in a previous work [21]. The higher value of FI in herd C than herd B is difficult to explain since early weaning which has been reported to positively influence farrowing interval was practiced in herd C, suggesting the involvement of other factors

Piglet mortality remains a problem for pig production despite improved technology and management [22]. Prewaning deaths take a high toll and greatly hinder improvement of reproductive efficiency in swine production [23]. Fifteen (15%) to 30% of live born piglets are reported to die before weaning, the major causes of death being chilling, starvation, overlaying by sows or infectious diseases [23]. High piglet mortality along with slow growth rate, lack of adequate feedstuffs and poor feed conversion ratio are considered to be responsible for the generally low productivity of pigs in developing countries [9]. Piglet mortality rates obtained in this study (25.22%) are higher than the acceptable value of (10%) for pigs. The preweaning mortality rate obtained in this study is lower than the rates of 29.3% and 44.5% reported for indigenous and exotic piglets respectively during the first week of life in Nigeria [24]. It is however higher than the figures of 18.5% in Benue and Kaduna states respectively [19] and 15% in traditionally managed herds in Nigeria [9]. The higher figures obtained in this study compared to the figures by these workers may be due to the higher ability of indigenous piglets to resist endemic diseases than their exotic counterparts [25]. The preweaning mortality rate obtained in this study is also higher than the figure of 11.3% reported in Japan [26] and 23.3% in Denmark [27]. The PWMR obtained in this study compares with the values of 13 to 15.4% reported by [20]. PWMR is influenced by LSAB and age of sows [27]. Older sows of parity 8 and above are also known to have increased PWMR. There is usually considerable variation in the herd - to - herd incidence of PWMR. The cause of PWMR was not investigated in this study. The high piglet mortality rate obtained in herd B relative to the other herds could not be readily explained but seems to reflect the efficient record keeping in this herd relative to the rest. The SB figure of 9.16% obtained in this study is higher than the acceptable figure of 5%, though 8 - 10% piglet

losses are considered normal [8] but comparable with values of SB values of 2.1 to 9.6% in Australia and Vietnam [12]. SB rate greater than 8% is considered to require intervention [18]. Stillbirth is considered as one of the most important reproductive disorders that compromise the future reproductive life of sows [29]. The causes of mortality were not investigated in this study. However, crushing, hypothermia and starvation are considered the direct predisposing causes [30].

The litter size at birth and at weaning obtained in this study compare well with the global means of these parameters (6.22 and 4.38 respectively). They are however lower than values of 8.0 and 6.6 for LSAB and LSAW respectively reported for smallholder piglets in same area [19]. Higher values (9.8 + 0.6 to 11.4 + 0.3) have been reported by other workers in temperate countries [31]. The LS of indigenous pigs has been reported to range from 6.7 under improved management condition [32] to 6.5 under village conditions [9]. These values are higher than the values reported by other workers [17,33 - 36]. Differences in both nutrition and management practices in tropical and temperate environments probably accounted for the disparity in values between the tropical and temperate environments. Feeding in the tropics is particularly not as adequate as in the temperate areas.

The average values of live weights at birth (1.02 kg) and at weaning (6.40 kg) obtained in this study are below the values of 3.25±0.08 kg and 23.93±0.85 kg for LWAB and LWAW respectively, in Assam indigenous pigs [17]. However, they are within the global range values of 1.0 - 9.0 kg for LWAB and 2.2 to 12.5 kg for LWAW, respectively [37]. The LWAW figures of 5.25 and 3.93 kg have been reported for Mexican breeds (Mexican hairless pigs (MHP) and Criole pigs (CP) [37]. The difference between these results may be due to the different breeds of sows and management practices. Piglets with large LWAB are less prone to death. However, there is a delicate balance between feeding of sows to ensure high LWAB and subsequent lactational performance. In addition, heritability for this trait is nil [23]. Since there were no indigenous breeds in these herds, a comparison of these performance indices for these and exotic breeds and their crosses could not be made.

In conclusion, the overall performance of sows in institutional swine herds is considered to be inadequate for swine optimal productivity in Benue state, Nigeria. It is therefore recommended that efforts be made to study the various factors that may constraints to efficient production.

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REFERENCES

1. Peltoniemi, O.A.T., C. Oliviero, O. Halli and M. Heinonen, 2007. Feeding affects reproductive performance and reproductive endocrinology in the gilt and sow. *Acta Vet Scand.*, Follow this Style in All References. 49(Suppl 1): S6.
2. Anderson, L.L., 1974. Pigs. In: *Reproduction in Farm Animals*. Hafez, E.S.E. (Ed.). 3rd edition. Lea and Fabiger. pp:175-287.
3. Hodson, H.H., 1980. Postpartum sow management for maximum reproductive performance. In: *Current Therapy in Theriogenology. Diagnosis, Treatment and Prevention of Reproductive Diseases in Animals*. Morrow, D. (Ed). W. B. Saunders. pp: 1096-1099.
4. Rekwot, P.I., J.O. Jegede, O.W. Ehoche and T.S.B. Tegbe, 2001. Reproductive performance in smallholder piggeries in northern Nigeria. *Trop. Agric.*, (Trinidad), 78: 1-4.
5. Day, B.N., 1974. . Reproductive problems in swine. *Beltsville Symposia in Agricultural Research*. 3. Animal Reproduction. Allanheld, Osmun and Co. Publishers Inc.,
6. Van der Leek, M.L. and H.N. Becker, 1993. Reproductive management problems in swine. In: *Current Therapy . 3. Food Animal Practice*. Howard, J. L. (ed). W. B. Saunders Co., pp: 805-809.
7. Benue State Government, BNSG, 2004. Benue State Economic Empowerment Development Strategy (BENSEEDS). Second Draft Report. pp: 1-136.
8. Otesile, E.B., A.T.P. Auwape, Odemuyiwa, S.O. Akpavie, A.K. Olaifa, G.N. Odaibo, O.D. Olaleye and A.T. Adetosoye, 2005. Field and experimental investigations of an outbreak of African swine fever in Nigeria. *Revue Elev. Med. Vet. Pays. Trop.*, 58(1-2): 21-26.
9. Pathiraja, N., P.I. Rekwot, E.O. Oyedipe, W.S. Alhassan and P.M. Dawuda, 1986. Studies on the pig production systems in southern Zaria. In: *Animal Production in Nigeria*. O.A., Osinowo, B.B.A. Taiwo, P.C. Njoku, T.S.B. Tegbe and M. Umaru, (Eds.). Proceedings of 11th Annual Conference Nig Soc For Animal Production. ABU Zaria. pp: 133-138.
10. Agyemang, K., D.A. Little, M.L. Bah and R.H. Dwinger, 1991. Effects of postpartum body weight changes on subsequent reproductive performance in N'dama cattle maintained under traditional husbandry systems. *Anim. Rep. Sci.*, 26: 51-59.
11. Rekwot, P.I., Y.U. Abubakar and J.O. Jegede, 2003. Swine production characteristics and management systems of smallholder piggeries in Kaduna and Benue states of north central Nigeria. *Nig. Vet. J.*, 24(2): 34-40.
12. Dan, T.T. and P.M. Summers, 1996. Reproductive performance of sows in the tropics. *Trop. Anim. Hlth. Prod. Afr.*, pp: 247-256.
13. Jogi, S., 1995. Factors affecting reproductive traits of native sows (*Sus scrofa domestica*). *Indian Vet. Med. J.*, 19: 216-217.
14. Kalita, D., 1995. Genetic studies on some of the economic traits of indigenous pigs and their crosses with Hampshire. M. V. Sc Thesis submitted to Assam Agricultural University, Guwahati.
15. Raju, K.S., 1998. Study on reproductive traits of indigenous pigs. *Indian J. Anim. Res.*, 32: 145-146.
16. Lemus, F.C., M.R. Ajonso, M. Alosa-Spilsbury and N.R. Famirez, 2006. Reproductive performance of Mexican Native pigs. *Arch. Zootec.*, 52: 109-112.
17. Phookan, A., S. Laskar, A. Aziz and R.N. Goswani, 2006. Reproductive performance of indigenous pigs of the Brahmaputra valley of Assam. *Tamilnadu J. Vet and Anim Sci.*, 2(4): 121-125.
18. Stein, T.E., 1990. Interpreting data from swine breeding herds. *Agri-Practice*. 11: 30-34.
19. Rekwot, P.I., Y.U. Abubakar . and J.O. Jegede, 2003. Swine production characteristics and management systems of smallholder piggeries in Kaduna and Benue states of north central Nigeria. *Nig. Vet. J.*, 24(2): 34-40.
20. Osteras, O., M.S. Gjetvang, S. Vatn and I. Solverod 2007. Perinatal death in production animals in the Nordic countries. *Acta. vet. Scand.* 49(Suppl): S14.
21. Goodwin, R.F.W., 1971. A procedure for investigating the influence of disease status on production efficiency in a pig herd. *Vet. Rec.*, 88: 387-392.
22. Svetina, A., L. Vrabac, M. Belic and R. Turk, 2006. Relation between erythrocyte parameters and stillbirth in piglets. *Vet. Arhiv.*, 76(4): 297-303.
23. Curtis, S.E. and K.W. Kelly, 1980. In: *Current Therapy in Theriogenology. Diagnosis, Treatment and Prevention of Reproductive Diseases in Animals*. Morrow, D. (Ed). W. B. Saunders. pp: 1086-1089.

24. Uko, O.J., A.M. Ajala and G.M. Babatunde, 1994. Preliminary study of the incidence of preweaning mortality in exotic and West African dwarf pigs in south Nigeria. *Rev. Elev. Med. Vet. Pays. Trop.*, 47: 329-332.
25. Ikeme, M.M. and O. Nduaka, 1974. Pig parasites of Nigeria. III. Local pig industries in the Plateau area of northern Nigeria and their helminth problems at the peak of the rains. *Bull. Epizoot. Dis. Afr.*, 22: 349-355.
26. Tanaka, Y. and T. Koketsu, 2007. A survey of reproductive performance and growth performance of pigs on commercial farrow - to- finnish swine farms. *J. Vet. Epid.*, 11(2): 18-22.
27. Svendsen, J., N.C. Nielsen, N. Bille and H.J. Riising, 1975. Causes of culling and death in sows. *Nord. Vet. Med.*, 27: 604-615.
28. Uremovic, M. and Z. Uremovic, 1997. *Svinjogojstvo agronomski fakultest Sveucillista u Zagreb*, pp: 222-258.
29. Correa, M.T., H. Erb and J. Scarlettz, 1993. Path analysis for seven postpartum disorders in dairy cattle. *Anim. Rep. Sci.*, 96: 240-249.
30. Oliviera, C., M. Heinonen, Pastell, J. Heikkonen, A. Valros, O. Vainnio and O. Peltoniemi, 2007. Modern technologies in supervision of parturition to prevent piglet mortality. *Acta. Vet. Scand.*, 49(Suppl): S12.
31. Engblom, L., E. Lundhein, A.M. Dalin and K. Anderson, 2007. Sow removal in Swedish commercial herds. *Liv. Prod. Sc.*, 106: 76-86.
32. Fetuga, B.L., G.M. Babatunde and V.A. Oyenuga, 1976. Performance of the indigenous pigs of Nigeria under intensive management conditions. *Nigeria J. Anim. Prod.*, 4: 43-51.
33. Deka, A.C., 1988. Performance of local, exotic and crossbred pigs under farm and village conditions. M. V. Sc. Thesis submitted to Assam Agricultural University, Guwahati.
34. Sylla, B., 1988. Genetic studies on some of the economic traits of indigenous pigs of Assam. M. V. Sc. Thesis submitted to Assam Agricultural University, Guwahati.
35. Kumar, S., S.K. Singh, R.L. Singh, B.D. Sharma, C.B. Durby and S.S.Verma, 1999. Effect of genetic and genetic factors on body weight, efficiency of feed utilization, reproductive performace and survivability in Landrace and their half breeds. *J. Anim. Sc.*, 60: 1219-1223.
36. Kalita, D., 1995. Genetic studies on some of the economic traits of indigenous pigs and their crosses with Hampshire. M. V. Sc. Thesis submitted to Assam Agricultural University, Guwahati.
37. Lemus, F.C., M.R. Ajonso, M. Alosa-Spilsbury and N.R. Famirez, 2006. Reproductive performance in Mexican Native pigs. *Arch. Zootec.*, 52: 109-112.