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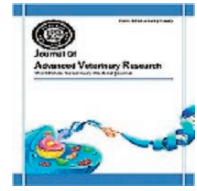
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Reproductive Performances of Local Pigs in West African Countries: A Review

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ABSTRACT

The local pig is reared in all West Africa countries, and especially in small farms, playing so an important role in its preservation. This article reviews work done on reproductive performances of local pigs in West Africa. These performances focus on age at puberty, estrus and sex cycle, gestation length, prolificity, viability and growth before piglets weaning. Factors that can influence these parameters are included. Finally, the contribution of animal biotechnology to these performances improvement is discussed.

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Introduction

Pigs reared in West African countries are of three genetic types. These include local pigs, exotic-breed pigs (Large White, Landrace, Pietrain, Meishan) and crossbreeds between local pigs and exotic breeds (Ironkwe and Amefule, 2008; Djimenou *et al.*, 2017; Youssao *et al.*, 2018). Local pigs are mostly reared in free-range or in temporary confinement, resulting in low zootechnic performances (Youssao *et al.*, 2008; Dotché *et al.*, 2018). Therefore, they are reared mostly by small rural farmers in traditional system. On the other hand, their meat is highly valued by consumers compared to exotic pork because it is marbled (Deka, 2008). This meat appreciation by the population and the local pig high adaptation to our climatic condi-

tions aroused lots of work to improve its numerical and weight productivity. This work has exposed the constraints that reduce the performance of this breed, such as the low level of know-how of farmers, absence of quality feed in farms, absence of appropriate management and marketing structures and health problems and animal material and equipment supply (Youssao *et al.*, 2008; Ndébi *et al.*, 2009; Porphyre, 2009; Mopaté *et al.*, 2014). In order to find solutions to these constraints, local sows numerical productivity has been improved by the breeding mode improvement (Koutinhoun *et al.*, 2009). Growth performance was also improved through crossbreeding with the exotic breeds Large White and Landrace (Youssao *et al.*, 2009b; Nwakpu and Onu, 2011). The reproductive parameters, such as farrowing interval, weaning-to-mating interval, and age at the first farrowing are very little reported in these various work. However, the development of this local pig's breeding will also require the control of their reproduction, influencing then their interest in an important economic

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perspective in breeding.

This review aims to make a point of work carried out on the reproductive performances of local pigs in West Africa in order to contribute to the setting of strategies improving their productivity.

Distribution and denominations of local African pig in West Africa

Local pigs (Figures 1 and 2) are reported in all countries in West Africa, from Senegal to Nigeria (Meyer, 2019). This breed origin is controversial, but recent work on molecular genetic characterization has admitted that local pigs' breeds could come from the Middle East through Egypt and from the Far-East through trades across Indian Ocean, this because alleles and genes of breeds from these areas are found in local breeds (Ramírez et al., 2009; Amills et al., 2013; Lesur-Gebremariam, 2014; Agbokounou et al., 2016; Osei-Amponsah et al., 2017). Several terminologies are used to name this animal according to countries. For example, it is called West African Dwarf pig (Nigeria) and Ashanti pig (Ghana) (Meyer, 2019). This breed has almost the same phenotypic characteristics in all African countries where it exists. It is a small animal that has a uniform black or white color, sometimes pieblad, and with long or short dense hairs (Alenyorege et al., 2015; Youssao et al., 2018). Its body is 49 to 52 cm long and ends with a long head (25 cm) (Okoro et al., 2015; Youssao et al., 2018). Found in most of the African countries, it tolerates food irregularities and is heat-resistant, and for that is more bred in traditional livestock farms, especially in rural areas (Agbokounou et al., 2016; Dotché et al., 2018). In this system, the breeder gives little importance to his feeding and to the health monitoring. The feeding consist to the distribution of cereal and fruit residues, of leguminous plants and of food leftovers (Ossebi et al., 2018). It is appreciated by breeders for its disease resistance and by consumers for its meat quality (Agbokounou et al., 2016). Unfortunately, these performances are low and are improved by exotic pigs in farms. The weight at 180 days old is 19.2 kg (Darfour-Oduro et al., 2009) and when the animal is 365 days old (1 year) (Abdul-Rahman et al., 2016), its weight is 51 kg. Beyond one year, the weight reaches 62 kg (Karnuah et al., 2018).



Fig. 1. Local sow

Age at puberty and age at first mating

Local pig has sexual precocity that is not valued in traditional breeding (Agbokounou et al., 2016). Under traditional breeding conditions, the age at puberty of West Africa local pig ranges from 221 days to 245 days and sometimes 302 days in free range (d'Orgeval Dubouchet, 1997; Nonfon, 2005; Nwakpu and Ugwu, 2009; Nwakpu and Onu, 2011; Agbokounou et al., 2016). This age is similar to the reported age of



Fig. 2. Local boar

210 days for local pig in Central Africa (Mopate et al., 2011) and of 254.5 days for Bangladesh (Ranjit Chandra Sinha et al., 2015). By improving feeding, the age at puberty decreases to 146/150 days (Chiboka, 1981; Nonfon, 2005). This age is the same in the local pig (149 days) in Central Africa (Cameroon) in improved farm (Kouamo et al., 2015). The age at puberty is 262 days for Landrace and 267 days for Large White (Nwakpu and Ugwu, 2009; Nwakpu and Onu, 2011). The age at puberty of sows is influenced by temperature, light, group or individual breeding, confinement or freedom, male exposure and feeding (Knox and Wilson, 2007; Leborgne et al., 2013). The age at puberty of these exotic pigs does not differ from that of the local pigs when they are reared under the same conditions (same feeding, habitat and health monitoring) (Nwakpu and Ugwu, 2009). However, this performance similarity is observed especially in improved farm and these foreign breeds rearing in traditional farm may affect this parameter if sows do not die. Variations in age at puberty in different studies and regions are due to variations in breeding practices, feeding practices, climatic conditions and genetic types (Ranjit Chandra Sinha et al., 2015).

The age at first mating in improved breeding system in Benin is 6 months (Youssao et al., 2009a, 2009b). The growth delay caused by the mismanagement in traditional breeding mode increases the age to 9 months (Dotché et al., 2018). The age at puberty of local boar in West Africa is not reported in the literature, but local boar in the tropical region reaches puberty around 4 months (Holnes and Chaboef, 1997) and is used to mate sow at 8 months of age (Dotché et al., 2018).

Estrus and sexual cycle

The sexual cycle of the local sow is continuous and lasts 21 days (Aladi et al., 2008). This can sometimes reach 22 days (Mezui-Mezui, 2000). The cycle duration is the same for local sows in Bangladesh (Ranjit Chandra Sinha et al., 2015) and European breeds (IFIP, 2013; Leborgne et al., 2013). Thus, the genetic type did not influence the sexual cycle. During estrus, there are changes in behavior and in genital organs. Estrus usual signs in sows are: vulvar reddening and swelling, mucous discharge, nervousness, increased activity, and standing at the boar (Helke et al., 2015). In the local sow, estrus is less detectable in pubertal gilt than in sow of at least one farrowing and the most effective estrus indicator was the immobility reflex in a boar presence (Aladi et al., 2008). Vulva swelling is minimal in local sows and vulva generally appears dark in contrast to the red color reported in exotic breeds such as Large White (Aladi et al., 2008).

The estrus duration of the local sow varies between 2-3 days (Mezui-Mezui, 2000). The cycle other periods' duration are 2-3 days for metoestrus, 14-15 days for dioestrus and 3 days for pro-estrus (Mezui-Mezui, 2000). The progesterone concentration varies from phase to phase (Mezui-Mezui,

2000). During each phase, progesterone concentration often varies from single to double, from female to female (Mezui-Mezui, 2000). These variations in progesterone concentration are not specific to the local sow; they are also found in exotic sows (Mezui-Mezui, 2000; IFIP, 2013). The matings are performed at two thirds of the estrus period. Weaning-mating interval is very long (at least 8 weeks) in traditional breeding (Buldgen et al., 1994; Dotché et al., 2018). When housing and feeding conditions are improved, this interval decreases by 3 weeks or 5 weeks after weaning (Dotché et al., 2019). Apart from breeding hard conditions (inadequate feeding, care and habitat) that would justify this situation, breeders lack in know-how makes estrus often unnoticed (Dotché et al., 2019). Sows are mated between 31 and 41 days after weaning in improved farms with improved pigs (Dotché et al., 2018, 2019; Abah et al., 2019).

Duration of gestation

Pregnancy diagnosis in sows in West Africa is performed by observing estrus signs 20 to 21 days after mating (Aladi et al., 2008). The gestation length of local sows in improved breeding in West Africa ranges from 111 to 114 days (Chiboka, 1981; Aladi et al., 2008; Nwakpu and Onu, 2011). Gestation length is difficult to determine in traditional breeding because dates of mating are not often known in this system. The traditional breeding is characterized by animals' divagation and matings are performed without the knowledge of the breeder. The gestation length is not very dependent on the age at first mating (Chiboka, 1981). This duration is 113 days for matings between 7 and 9 months of age and 114 days for females mated between 11 and 13 months of age (Chiboka, 1981). The gestation lengths of local sow are shorter than those of exotic breeds sows (Large White and Landrace) and their crossbreds with the local pig in West Africa (Aladi et al., 2008; Nwakpu and Onu, 2011). These exotic or crossbred sows have a gestation length ranging from 116 to 122 days (Aladi et al., 2008; Nwakpu and Onu, 2011). The difference between the gestation length of local sows and exotic sows in West Africa may be due heat stress influence on exotic sows. Heat stress (temperature and humidity of the air) reduces the reproductive performances by increasing respiration and rectal as skin temperatures and by reducing feed consumption and sow activity (Suriyasomboon et al., 2006; Williams et al., 2013; Lucy and Safranski, 2017). This effect must be more elucidated by studies in our breeding conditions since Lucy and Safranski (2017) report a decrease in gestation lengths in sows submitted to heat stress in USA while Suriyasomboon et al. (2006) report no effect of heat stress on gestation lengths of sow in Thailand.

Age at first farrowing and farrowing interval

Age at first farrowing is one of the factors that used to estimate age at the first fertile mating, especially in traditional breeding where matings took place in divagation. In Benin, this age is 369 days for local sows in traditional breeding (d'Orgeval Dubouchet, 1997; Nonfon, 2005). The age at first farrowing in traditional farms dominated by the local breed in Senegal ranges from 383 to 495 days (Buldgen et al., 1994; Missohou et al., 2001). The age at first farrowing of sows in West Africa is similar to that of local sows in Central Africa (Mopate et al., 2011). The farrowing interval of local sows in traditional farms is 209 days and 180 days in improved breeding (d'Orgeval Dubouchet, 1997; Kiendrebeogo et al., 2012). The same intervals are reported in Large White sows (Kiendrebeogo et al., 2012). This interval is influenced by the estrus detection technique and is longer when estrus goes unno-

ticed.

Litter size at birth

Litter size at birth of local sow in West Africa ranges on average from 5.3 to 8.8 piglets (Table 1). The litter size is higher in improved breeding mode where sows are well fed and better monitored. Thus, litter sizes are 5.3 piglets (Koutinhouin et al., 2009) and 5.7 piglets (Youssao et al., 2008) in traditional breeding in Benin compared to 7.2 to 7.5 piglets (Youssao et al., 2009a, 2009b) and 8.8 piglets (Koutinhouin et al., 2009) in improved breeding. This difference is justified by the embryonic mortality reduction due to dietary supplement provided to sows in improved breeding (Koutinhouin et al., 2009). The farrowing season influences the litter size. It ranges from 4.7 to 6.4 piglets in the rainy season compared to 6.3 to 6.6 piglets in the dry season (Oseni, 2005; Oluwole and Omitogun, 2015). The litter size at birth of local pigs is lower than that of exotic pigs ranging from 8 to 10 piglets for Large White in improved breeding in Benin (Youssao et al., 2009b; Nwakpu and Onu, 2011) and 9 piglets for the Landrace in Nigeria (Nwakpu and Onu, 2011). An improving crossbreeding to 75% of Large White blood improves the local sow litter size at birth.

Born alive number and viability at weaning

The number of piglets born alive per litter of the local sow ranges from 4.6 to 8.3 (Youssao et al., 2008, 2009a, 2009b; Koutinhouin et al., 2009). This number varies depending on the breeding mode (Koutinhouin et al., 2009). In traditional mode, the number of born alive is 5 piglets (Youssao et al., 2008; Koutinhouin et al., 2009) compared to 6 to 8 in improved mode (Youssao et al., 2008; Koutinhouin et al., 2009).

The stillborn rate ranges from 17% to 19% (Youssao et al., 2008; Youssao et al., 2009a) and is influenced by the breeding mode. It is higher in traditional mode than in improved mode (17% vs 19%) (Youssao et al., 2008, 2009a; Koutinhouin et al., 2009). The number of stillborn is one piglet per litter (Koutinhouin et al., 2009). The average of birth- weaning mortality rate ranges from 15% to 33% (d'Orgeval Dubouchet, 1997; Nonfon, 2005; Youssao et al., 2008, 2009b; Koutinhouin et al., 2009; Agbokounou et al., 2017b). This rate is higher in traditional breeding than in improved breeding (Youssao et al., 2008, 2009b). The lack of animal care in traditional breedings favors the outbreak of diseases like scabies and other diseases symptoms such as diarrhea, cough, and weight loss that cause these mortalities (Youssao et al., 2008). Mortalities appear mainly from the second week, because the rate of antibodies transfer from sows to piglets is very low (Agbokounou et al., 2017b).

The litter size of local sow at weaning ranges from 3.4 to 5.7 piglets (Oseni, 2005; Koutinhouin et al., 2009; Youssao et al., 2009b; Nwakpu and Onu, 2011). It is higher in improved breeding than in traditional (Koutinhouin et al., 2009; Youssao et al., 2009a). The litter size at weaning is 3.4 piglets over 4.9 born alive in traditional breeding and 5.6 piglets over 8.3 born alive in improved breeding (Koutinhouin et al., 2009). The 8-week-old local piglet survival rate is higher in the dry season than in the rainy season (86.91 vs 77.78%) (Oluwole and Omitogun, 2015).

Weight at birth

The local piglet weight at birth ranges from 535 g to 810 g (Uko et al., 1994; Koutinhouin et al., 2009; Youssao et al., 2009a, 2009b) in traditional breeding and from 650 g to 1180 g in improved breeding where animals are well fed and given care (Table 1). It varies from country to country because of the

breeding mode differences. In Benin, local piglets weight at birth ranges from 531 g to 658 g (Youssao et al., 2008, 2009b; Koutinhouin et al., 2009). This weight is from 800 g to 920 g in Nigeria (Oseni, 2005; Nwakpu and Onu, 2011; Okoro et al., 2015) and about 1000 g in Ghana (Darfour-Oduro et al., 2009; Abdul-Rahman et al., 2016). It decreases with litter size increase (Abdul-Rahman et al., 2016) and beyond 8 piglets, the weight becomes lower (Abdul-Rahman et al., 2016) and piglet's survival chance at weaning is reduced. The birth weight of local piglet is improved by crossing with exotic breeds (Youssao et al., 2009b) and a local piglet is less heavier than an exotic piglet in improved breeding (Aladi et al., 2008; Youssao et al., 2009b). This weight ranges from 852 g to 1300 g for local x Large white crossbred piglets (Nwakpu and Ugwu, 2009; Youssao et al., 2009b) and from 1170 g to 1800 g for local x Landrace crossbreeds piglets (Nwakpu and Ugwu, 2009). For exotic breeds reared in improved mode, the birth weight is 886 g for a Large White piglet in Benin (Youssao et al., 2009a) and ranges from 1300 g to 1500 g for a Large White or Landrace piglet in Nigeria (Aladi et al., 2008; Nwakpu and Ugwu, 2009). On the contrary, sex, breeding mode and farrowing season do not influence piglet birth weight (Abdul-Rahman et al., 2016; Koutinhouin et al., 2009; Oluwole and Omitogun, 2015).

Piglet growth and weaning weight

The local piglets growth in traditional breeding system is low (Figure 3). The birth-weaning average daily gain ranges from 30 to 34 g/d (Koutinhouin et al., 2009; Agbokounou et al., 2017b). When the breeding conditions are improved, this average daily gain increases to 55 g/d (Koutinhouin et al., 2009). Under improved breeding system, local pigs have a lower growth rate between birth and weaning than exotic pigs (Large White) (Okeudo et al., 2007; Youssao et al., 2009b). Local piglets female and male do not have significant difference in growth rates in the traditional system (Koutinhouin et al., 2009). By contrast, in improved breeding, males grow faster than females between birth and weaning (Youssao et al., 2009a).

The weaning weight (at 62 days) of local piglet in im-

proved breeding system is 4.5 kg in Benin (Youssao et al., 2009b) and ranges from 3.8 kg to 6 kg in Nigeria (Aladi et al., 2008; Ajayi and Akinokun, 2013; Oluwole and Omitogun, 2015). In Ghana, weaning weights reported are 5.7 to 6.2 kg per piglet (Abdul-Rahman et al., 2016; Darfour-Oduro et al., 2009). Season and sex do not influence the weight of piglet at weaning (Abdul-Rahman et al., 2016; Oseni, 2005; Oluwole and Omitogun, 2015). On the other hand, the litter weight at weaning is improved by the breeding mode (Koutinhouin et al., 2009) and by crossing with exotic breeds (Oseni, 2005). The litter weight of local pigs is 9.6 kg (3.44 piglets) in traditional breeding in Benin compared to 20.3 kg (5.6 piglet litter) in improved farming (Koutinhouin et al., 2009) and 32.5 kg in Nigeria (Oseni, 2005). Exotic pigs (Landrace and Large White) reared in West Africa have a heavier litter at weaning than local pigs (Nwakpu and Onu, 2011). It weighs 76.1 kg for Large White and 67.8 kg for Large White x local pig crossbreeds (Oseni, 2005). The genetic type effect on the litter weight is explained not only by the growth rate of exotic pigs and cross-breeds, but also by the litter size which is higher than that of the local breed. Besides, exotic pigs (Large White) and cross-breeds (Large White x local pig) have higher weight gains than local pigs in the first two months of life (Youssao et al., 2009a). It is important to note that weaning weight is difficult to determine in the traditional system because weaning is natural. The age at weaning is late and may reach 90 days in this system (d'Orgeval Dubouchet, 1997). Weaned piglets have birth weight significantly higher than birth-weaning dead piglets (0.73 ± 0.05 vs 0.54 ± 0.07 kg) (Uko et al., 1994).

Age at weaning

The age at weaning of local piglets in West Africa ranges from 41 to 90 days (Table 1). This age is influenced by breeding mode. When sows are reared in a system where they are well fed and given care, piglets grow faster and are weaned earlier. For example, the age at weaning reported in improved mode is 50 days compared to 53 days in traditional mode (Koutinhouin et al., 2009). On station in Benin, the age at weaning is 62 days (Youssao et al., 2009b) and 41 days in Nigeria (Aladi et al., 2008). In traditional breeding, piglets are

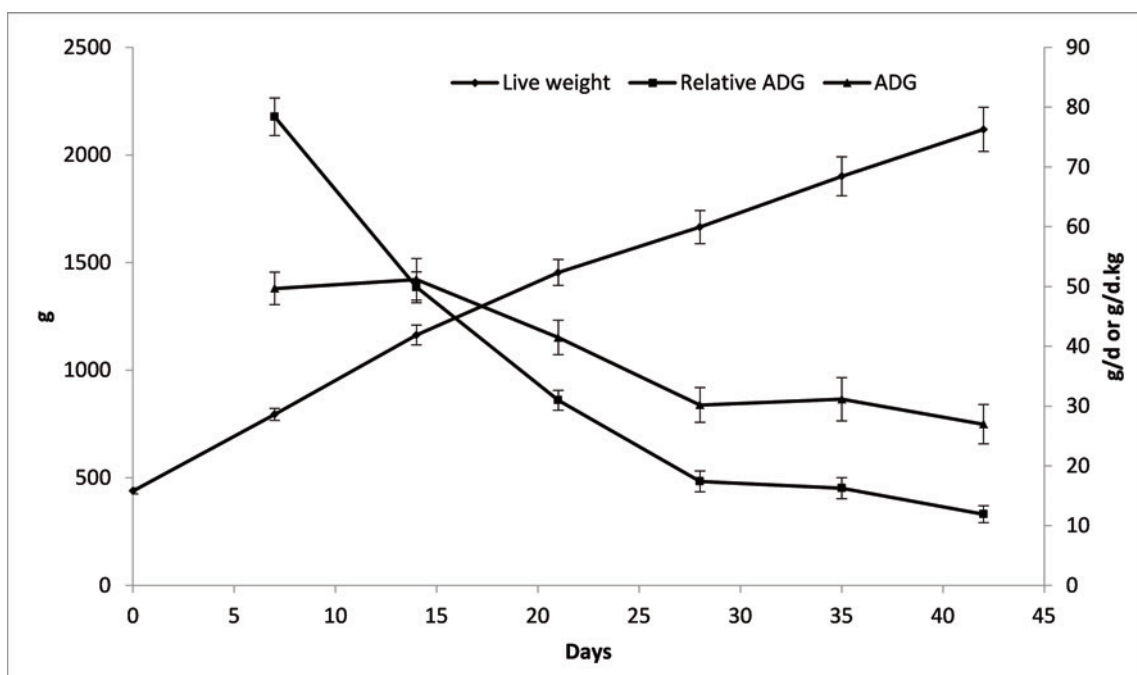


Fig. 3. Evolution of live weight, Average Daily Gain (ADG) and relative Average Daily Gain (RADG) in local breed of piglets in Benin (Agbokounou et al., 2017a).

weaned at 90 days (d'Orgeval Dubouchet, 1997). The differences between the weaning ages are due to the breeding conditions of systems and to the genetic diversity of local breed between West African countries.

Milk production

Local sow milk production in 56 days is 79.4 kg (Adebambo and Dettmers, 1982). This milk contains 9.3% of lipid, 6.9% of protein, 5.4% of lactose, 0.5% of calcium and 0.2% of phosphorus (Adebambo and Dettmers, 1982). Colostrum in local sows is concentrated in IgG (22 mg/ml) but these antibodies are lowerly transmitted to piglets (Agbokounou et al., 2017b). Thus, piglets serum IgG concentration at 7 days old is 2 mg/ml compared to 7 mg/ml obtained in improved breeds (12-18 mg/ml in sows) despite the good IgG content of

colostrum (Agbokounou et al., 2017b).

Improvement of reproductive performances through biotechnology

Reproductive biotechnologies include techniques such as artificial insemination, embryo transfer, sexing and cryopreservation of gametes and embryo, in vitro fertilization, cloning or transgenesis (Bidanel et al., 2003). Among reproductive biotechnologies, artificial insemination is the most widely used in animal production in Africa (FAO, 2008). In pig farms in West Africa, the possibility of the use of artificial insemination to improve zootechnical performances was discussed in Nigeria in 1977 (Dede and Steinbach, 1977) and conditions for its implementation were studied in Benin in 2005 (Ayssiwede, 2005). It was included in the genetic improvement program in Côte

Table 1. Reproductive performances of local pig in some Africans countries

Parameters	Countries	Value	Author
Age at puberty (days)	Nigeria	245.00±3.00	Nwakpu and Onu (2011)
	Benin	118.00	Nonfon (2005)
Gestation length (days)	Nigeria	111.00±1.00	Nwakpu and Onu (2011)
		111.7±0.79	Aladi et al. (2008)
		113.0-114.0	Chiboka (1981)
Litter size at birth	Benin	5.50±1.96*	Agbokounou et al. (2017b)
		5.70 2.10	Youssao et al. (2008)
		7.20±2.30	Youssao et al. (2009b)
		7.50±1.90	Youssao et al. (2009a)
		8.80±3.20	Koutinhouin et al. (2009)
	Burkina	7.00±2.00	Kiendrebeogo et al. (2012)
	Ghana	7.50±10	Abdul-Rahman et al. (2016)
	Nigeria	6.50 ±0.02	Nwakpu and Onu (2011)
5.10±1.70		Aladi et al. (2008)	
5.30±0.30		Nwakpu and Onu (2007)	
8.00±1.00		Oseni (2005)	
6.80		Oseni (2005)	
Litter size at weaning	Benin	4.90±2.30*	Agbokounou et al. (2017a)
		5.70±2.00	Youssao et al. (2009b)
		5.60±2.60	Koutinhouin et al. (2009)
		3.40±1.50*	Koutinhouin et al. (2009)
	Nigeria	5.50±0.10	Nwakpu and Onu (2011)
Birth weight (kg)	Benin	5.50	Oseni (2005)
		0.40±0.100*	Agbokounou et al. (2017a)
		0.50±0.10	Youssao et al. (2009a)
	Ghana	0.60	Koutinhouin et al. (2009)
		0.70*	Koutinhouin et al. (2009)
		1.00±0.30	Abdul-Rahman et al. (2016)
Nigeria	1.00±0.20	Darfour-Oduro et al. (2009)	
	0.80	Nwakpu and Onu (2011)	
	0.80	Oseni (2005)	
	0.90	Ajayi and Akinokun (2013)	
	0.90	Okoro et al. (2015)	
Weight at weaning (kg)	Benin	4.50±0.90	Youssao et al. (2009a)
	Ghana	6.20±0.90	Abdul-Rahman et al. (2016)
		5.70±1.20	Darfour-Oduro et al. (2009)
	Nigeria	3.80	Aladi et al. (2008)
		5.10-6.00	Oluwole and Omitogun (2015)
Age at weaning (days)	Benin	4.00	Ajayi and Akinokun (2013)
		61.90±8.80	Youssao et al. (2009a)
		50.30±2.40	Koutinhouin et al. (2009)
	Nigeria	52.67±2.00*	Koutinhouin et al. (2009)
		40.90±7.50	Aladi et al. (2008)

* data reported in traditional method

d'Ivoire in 2008 (Tra Bi Tra, 2009) and in Benin in 2015 (Yousso, 2015). In Nigeria, following work on conditions and benefits of this biotechnology introduction in pig farms in 1977 (Dede and Steinbach, 1977), it was introduced in the 2000s and sows were inseminated in farms and research centers for zootechnical performances improvement in local pigs (Ugwu et al., 2009; Oniku et al., 2014). It is most of the time used to facilitate animal selection and crossbreeding programs in genetic improvement schemes. This is the case in Nigeria where it was used in the genetic improvement program of local pig by crossbreeding with exotic pigs (Ugwu et al., 2009). Performances improvement of pigs through artificial insemination in Côte d'Ivoire really began in 2012 and sows were inseminated with fresh semen (refrigerate at 17°C) from exotic pigs from France (Bitty, 2014). Following these inseminations, reproductive and growth performances was improved compared to sows mated by local boars on monitored farms (Bitty, 2014). Besides, crossbreedings between local and exotic breeds in Benin (Large White) has improved litter size, birth and weaning weights of animals (Yousso et al., 2009b). The genetic program continues today in Benin in pig farms of Ouémé and Plateau departments in the framework of the project on the professionalization of pig chain in Benin where, local sows are inseminated with semen from Landrace and Piétrain boar.

Conclusion

The reproductive performances of local pig is influenced by many factors such as feeding and breeding mode. Their performances is greatly improved by crossbreedings with exotic breeds using artificial insemination. These factors' effect is shown on litter size, birth weight and age at weaning. The influence of other factors remains to be tested on reproductive performances. These factors are those that influence age at puberty, cycle and estrus durations as well as litter size. In addition, many lacking parameters are to be determined or completed in this species: age at puberty of sows and boars, sexual cycle and estrus durations, hormones in the estrus and their levels.

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