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REGULAR ARTICLES

Comparison of reproductive performances of local and improved pigs reared in south Benin

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Abstract
Benin's domestic production of pork is deficient because of the animals' low productivity. This study aimed to evaluate the zootechnical performances of pigs reared in south Benin. Data on zootechnical performances and reproduction management were collected from 63 farms in the departments of Ouémé and Plateau. These data were analyzed with SAS software, and the Fisher test was used for the significance of the breed, sex, and parity number effect on the zootechnical performances. It appears that estrus detection was mainly based on the observation of signs of vulvar changes and behavior of the sow. These estruses were detected at any time and without the boar. The local sows were mated as soon as estruses were detected while improved sows were mated 36 h after. The pregnancy detection was performed by control of return of estrus, 21 days after the mating by the majority (80.6%) of the respondents. The litter size, the number of piglets born alive, and the weaned piglets of improved sows were significantly higher ($P < 0.001$) than those of local sows. These parameters increased with the parity number until the 4th parity and decreased after. The litter size was highly correlated with the number of piglets born alive and weaned piglets. The farrowing interval was longer in local sows than in improved sows. The weights at birth, at 1 and 2 months old of improved piglets, were significantly higher than those of local piglets ($P < 0.001$). The knowledge of these performances will allow actions to be taken for their improvement.

Keywords Pig · Zootechnical performances · Reproduction management · Benin

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Introduction

Pig breeding in Benin involves two main pigs' genetic types: improved and local pigs (Youssao et al. 2018). Improved pigs represent animals of unknown genetic type but which would be unregulated crossbreeding between exotic pigs (Large White or Landrace) (Youssao et al. 2018). Beyond these two breeds, we find in some farms their crossbreds (Youssao et al. 2018). These animals are reared in private farms, state farms, and in research centers. At state farms and research centers, animals are well monitored and used in several studies for the assessment and improvement of animals' zootechnical performances. These studies made available data on the animals' performances under the improved breeding conditions of the centers (Youssao et al. 2009a, 2009b). By contrast, on private farms, where most of the reared pigs in Benin are held, data on the zootechnical performances (reproduction and production) are not available. The animal breeding modes in research centers and on private farms are not the same. In research centers, animals are well fed and well cured and their growth controlled. In private farms, farmers do not have feed formulas and the feeds served to animals consisted of a random mixture of two or several raw materials, kitchen and crop waste and fodder (Kiki et al. 2018). In these farms, treatments are not appropriate and sometimes given by farmers themselves due to the lack of money (Houndonougbo et al. 2012). The assessment of pig breeding characteristics on private farms revealed that their production and reproduction performances were generally low (Ayssiwede 2005). Thus, several studies were carried out in order to improve these performances through animal management, habitat, health, and feeding (Kouthinhouin et al. 2009; Houndonougbo et al. 2012; Kiki et al. 2018; Youssao et al. 2018). Despite these improvement efforts, reproductive and production performances of reared pigs are low (Agbokounou et al. 2017) and do not allow domestic pork production to meet the population needs. In order to, in a participatory way, improve animals' productivity with the concerned actors, an evaluation of selection criteria of reproductive animals was first performed to allow pig farmers, following their farm typology, to select animals according to their production objectives and to achieve significant genetic progress (Dotché et al. 2018). Then, the crossbreeding modes carried out on pig farms were characterized, and the consanguinity effects on the zootechnical performances of pigs on these farms were evaluated (Dotché et al. 2018). The aim of the present study was to evaluate the reproductive performances of pigs reared in Benin in order to set an integrated strategy to improve the animals' numerical productivity by considering the production environment.

A comparison of the reproductive performance of the two main genetic types reared was carried out in order to characterize them from the zootechnical level in order to enhance them from the genetic level through the selection within each genetic type or the crossbreeding between these two genetic types.

Materials and methods

Study area

The data were collected in the departments of Ouémé and Plateau from May 2015 to September 2017. The department of Ouémé is located between 6° 40′ 0″ latitude north and 2° 30′ 0″ east longitude and covers an area of 1281 km^2 (1.12% of the national territory) with a population of 1,100,404 inhabitants (INSAE 2013). Data were collected in the cities of Adjarra, Aguégués, Avrankou, Porto-Novo, and Sèmè-Kpodji (Fig. 1).

The Plateau department is between 7° 10′ 0″ north latitude and 2° 34′ 60″ east longitude and covers an area of 3264 km^2, or about 3% of the national territory for a total population of 622,372 inhabitants (INSAE 2013). Data were collected in the Adja-Ouèrè and Pobè cities of this department (Fig. 1).

These two departments belong to the sub-equatorial region with four seasons: a long rainy season (April–July); a short dry season (August–September); a short rainy season (October–November); and a long dry season (December–March).

Study animal and data collection

Zootechnical performance data were directly recorded in 63 pig farms (39 in improved pig farming and 24 in local pig farming). These data were collected on two genetic types (local and improved pigs). Improved pigs represent animals of exotic breeds (Large White and Landrace) and products of their crossbreeding (Youssao et al. 2018). These pigs are 79.1 cm long with a 23.1-cm-long pelvis and 31.4-cm-long head. The height at withers is 75.1 m and the chest perimeter is 117.2 cm (Youssao et al. 2018). The bristles are mostly long, and the coat color is mostly white. The head had a generally concave profile and ended with a short, cylindrical snout with an average circumference of 37.4 cm (Youssao et al. 2018). These ears are erect and oriented forward. The pigs were reared in improved habitats built in bricks with sheet metal roofs. The animals were fed with the processing by-products of agricultural products (maize bran, soybean, cassava peelings, palm crab, etc.) and fodder. Some breeders gave commercial feeds to their animals.

The local pig is 52.2 cm long and the line of the back is straight. The width at the hips is 12.4 cm and the top of the shoulder is 17.4 cm. The height at withers is 47.3 cm and has a chest circumference of 78.8 cm. The bristles were mostly short, and the coat color is white or black uniform. The head is 25.3 cm long with a straight facial profile. The ears are erect, 10.8 cm long, and oriented upwards. The snout was long and thin or short and cylindrical with a circumference of 29.2 cm (Youssao et al. 2018). Local pigs were reared in traditional habitats built in wood or bamboo with sheet metal roofs or straw roofs. The animals were fed with the processing by-products of agricultural products (maize bran, soybean, cassava peelings, palm crab, etc.) and fodder.

The reproductive performance data recorded were the following: parity number, fertilizing mating date, farrowing date, litter size, number of piglets born alive, number of piglets at weaning, and the weaning date. Data were used to determine the gestation length, first farrowing age, farrowing interval, piglet viability, litter average size, number of stillborn piglets and at weaning, number of weaned piglets, weaning-mating interval, and the weaning age. These data were collected from 166 litters of 77 improved sows and from 53 litters of 13 local sows. Concerning the growth performances, the recorded data were the weight at the birth, 1 and 2 months. The weights of 264 improved piglets and 52 local piglets were taken with two

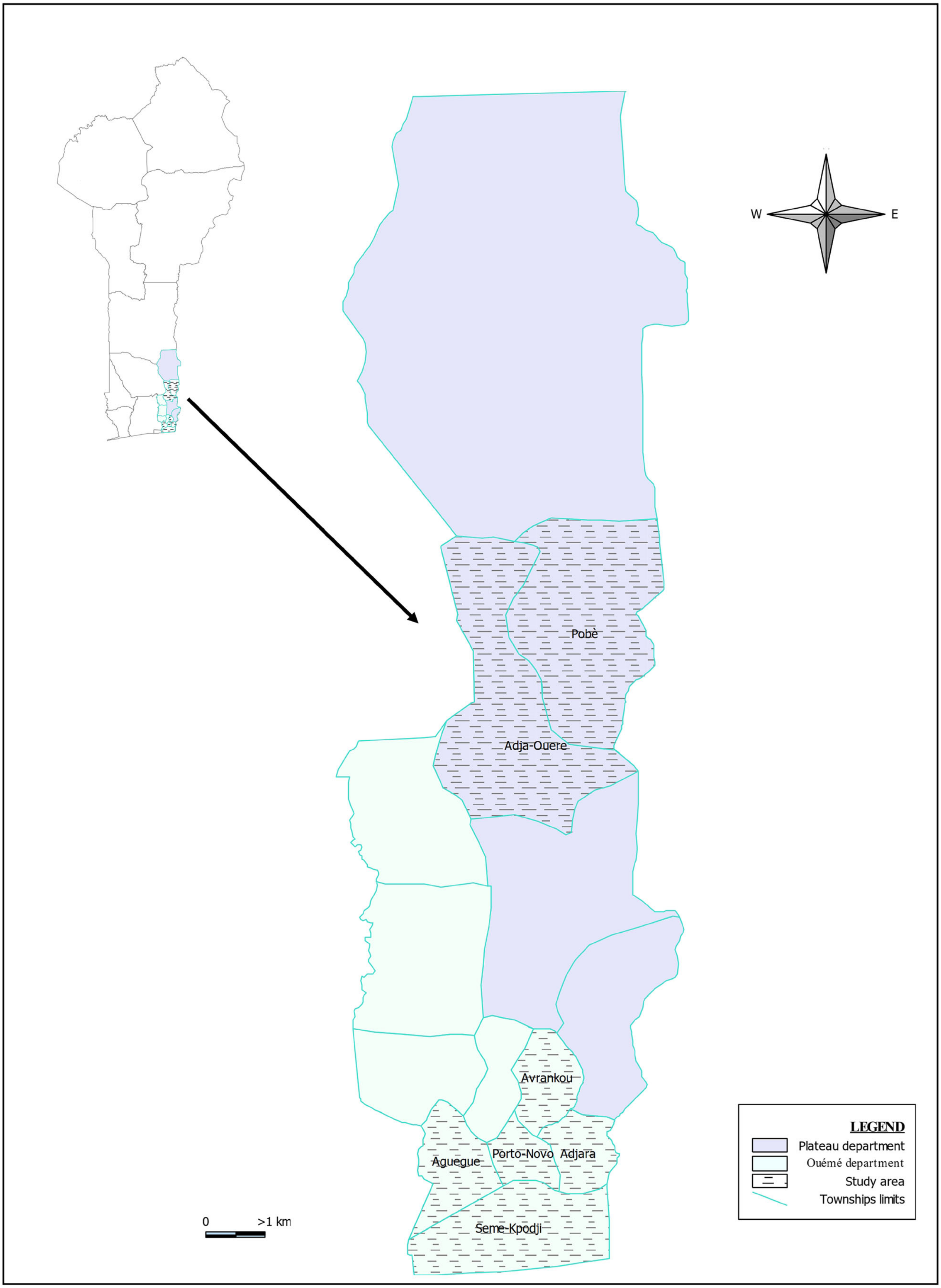

Fig. 1 Study area of reproductive performances of pigs reared in Ouémé and Plateau

electronic balances Weiheng (Hong-Kong, Chine) of maximum capacity of 45 kg and an accuracy of 5 g. Females and piglets were kept in permanent confinement in the farms. A survey was also carried out in these farms in order to collect information about the reproduction management mode. Thus, data on the reproductive animals' management, estrus detection, mating, feeding, pregnancy detection in the farms, and various constraints were collected.

The live-born rate, stillborn rate, birth-weaning mortality rate, and weaning rate were determined using the formulas:

$$\text{Born alive rate} = \frac{\text{Number of piglets born alive}}{\text{Total number of piglets born}} \times 100$$

$$\text{Stillborn rate} = \frac{\text{Number of stillborn}}{\text{Total number of piglets born}} \times 100$$

$$\text{Birth−weaning mortality rate} = \frac{\text{Birth−weaning dead number}}{\text{Total number of piglets born}} \times 100$$

$$\text{Weaning rate} = \frac{\text{Weaned number}}{\text{Number of piglets born alive}} \times 100$$

Statistical analysis

The zootechnical performances' data analysis was performed by adjusting two linear models with fixed effects to the zootechnical performance data (standard age weight, litter size at birth and weaning, the number of piglets born alive and stillborn, birth-weaning dead piglets, gestation length, age at weaning, age at first mating, age at first farrowing, farrowing interval, and weaning-mating interval) and includes the fixed effects of genetic type, sex, and parity number. Model 1 was adjusted to the reproductive performance data and model 2 was adjusted to the piglets' growth performance data. The interaction between genetic type and parity number was significant and taken into account in model 1 of variance analysis. In the same way, the genetic type and sex interaction was significant and taken into account in model 2. Regression (β) on litter size (P) was added as a co-variable in model 2. These two models are as follows:

Model 1:

$$Y_{ijkl} = \mu + B_i + F_j + BF_{ij} + \varepsilon_{ijkl}, \text{with :}$$

- Y_{ijk}: reproductive performance of k pig, of i genetic type and j parity number;
- μ: the general average value;
- B_i: fixed effect of i genetic type (local breed and improved breed);
- F_j: fixed effect of j parity number;
- BF_{ij}: interaction between i genetic type and j parity number of k animal;
- ε_{ijk}: random residual effect.

Model 2:

$$Y_{ijkl} = \mu + B_i + S_j + BS_{ij} + \beta P_{ijk} + \varepsilon_{ijkl}, \text{with :}$$

- Y_{ijk}: the growth performance of k pig, of i genetic type and j sex;
- μ: the general average value;
- B_i: fixed effect of i genetic type (local and improved breed);
- S_j: fixed effect of j sex;
- BS_{ij}: interaction between i genetic type and j sex of k animal;
- ε_{ijk}: random residual effect.

The generalized linear model procedure (Proc GLM) of SAS (2013) was used for the variance analysis, and then means were calculated and compared by the t test. Concerning qualitative variables, the frequencies were calculated by the Proc FREQ procedure of SAS (2013). Frequencies between the two breeds' farming were compared by pairs with the Z bilateral test. For each relative frequency, a confidence interval (CI) of 95% was calculated using the formula:

$$\text{CI} = 1.96\sqrt{\frac{[P(1-P)]}{N}}$$

where P is the relative frequency and N is the sample size.

Results

Reproduction management in farms

Estrus detection, sows and gilts mating, and pregnancy detection

In the two genetic types' farms, the reproductive females were each kept in her lodge. The estrus signs observed by the majority of improved pig breeders were either the vulva red dark color (82.1%), the vulva swelling (61.5%), or overlapping of others (48.7%). In the local pig farming, the sign observed by the majority of breeders was the vulva red dark color (91.7%). The vulva swelling was more reported ($P < 0.05$) by improved pig breeders than local pig breeders (61.5% vs 12.5%). The other estrus signs mentioned by the breeders were eating refusal, mucous discharges, immobility reflex, and voice changing (Table 1). The immobility reflex was more ($P < 0.05$) mentioned in improved pig farming than in local pig farming (25.6 vs 4.2%). It was the same for the eating refusal. The majority of breeders did not use the boar for estrus detection, and the boar's role for them was to mate females. Estruses were detected at any time of day by the majority of breeders of the two genetic types. The rest detected them in the morning, at noon, or in the evening (Table 1).

After estrus detection, natural mating was performed in all the surveyed pig farms. Mating periods after estrus detection were very diversified and ranged from 0 to 72 h (Table 2). The matings performed immediately (0–1 h) following estrus detection were more frequent ($P < 0.05$) in local pig farming than in improved pig farming (70.8% vs 28.2%). By contrast, the matings between 36 h and 72 h after estrus detection were more ($P < 0.05$) observed in improved pig farming than in local pig farming. For one estrus detected, sows/gilts were mated once, twice, or left with the boar during the estrus period (3 days). The majority (59%) of improved pig breeders mated once the sow and the majority of local pig breeders (52.2%) left the sow with the boar during the estrus period. The double mating was more applied ($P < 0.05$) in improved pig farming than in local pig farming (28.2 vs 4.2%). After mating, the majority of breeders performed the gestation diagnosis by observing or not the return of estrus 21 days after mating.

Reproductive animals treatment and difficulties encountered

The same type of food was served to all categories of animals (reproductive animals, fattening piglets, and gilts) in the farms; the food served to reproductive animals was mainly composed of two or more raw materials mixture and of fodder. Some breeders of improved pigs gave commercial or conventional feed to their animals. The raw materials used were oilseed cake, cereal bran, soy bran, and minerals. The treatment given to pregnant and lactating sows consisted of deworming, iron supplementation (Fercobsang®, Vétoquinol, Paris, France), vitamins (Stress-Vitam®, VETOQUINOL, Paris, France), and bacterial pathology treatment with antibiotics (Oxytetracycline®, VETOQUINOL, Paris, France). These treatments were more ($P < 0.05$) given to improved pregnant sows than local sows except during a fight against bacterial pathologies for which no difference was observed between the two pigs' management (Table 3). The worm control medicine used were Levalap®, Ivermectin®, and Bolumisole® (Laprovet-France). Improved nursing sows were more ($P < 0.05$) treated with antibiotics than local nursing sows (79.5% vs 50%). The proportion of breeders who gave iron to improved nursing sows was higher ($P < 0.05$) than that of local sows (79.5% vs 29.2%). It is the same for bacterial disease treatment. The main treatment given to piglets was the iron supply at birth week in the majority of pig breeding (Table 3). The difficulties encountered by the breeders were late estrus after weaning, mating failures, agalactia, tail biting, piglets crushing, anemia, and dead birth. Late estrus and anemia were significantly more reported ($P < 0.05$) in improved pig farming than in local pig farming.

Reproductive performances

The litter size of improved sows was significantly higher ($P < 0.001$) than that of local sows (8.9 vs 6.3 piglets). The

Table 1 Estrus detection in pig farms in the departments of Ouémé and Plateau

Variable		Improved pig farming			Local pig farming		
		n	Percentage	CI	*n*	Percentage	CI
Estrus sign	Eating refusal	39	38.5[a]	15.3	24	8.3[b]	11.1
	Red dark vulva	39	82.1[a]	12.0	24	91.7[a]	11.1
	Agitated	39	25.6[a]	13.7	24	12.5[a]	13.2
	Overlapping of others	39	48.7[a]	15.7	24	45.8[a]	19.9
	Mucous discharge	39	12.8[a]	10.5	24	25.0[a]	17.3
	Immobility reflex	39	25.6[a]	13.7	24	4.2[b]	8.0
	Voice changing	39	10.3[a]	9.5	24	8.3[a]	11.1
	Swollen vulva	39	61.5[a]	15.3	24	12.5[b]	13.2
Boar use in estrus detection	Yes	39	28.2[a]	14.1	24	20.8[a]	16.2
	No	39	71.8[a]	14.1	24	79.2[a]	16.2
Estrus detection moment	Morning	36	36.1[a]	15.7	24	30.4[a]	18.8
	Midday	36	2.8[a]	5.4	24	4.2[a]	8.0
	Evening	36	19.4[a]	12.9	24	16.7[a]	14.9
	Any time	36	50[a]	16.3	24	66.7[a]	18.9

The percentages of the same row followed by different letters differ significantly at the threshold of 5%

n number, *CI* confidence interval

Table 2 Animal mating in pig farms in Ouémé and Plateau

Variable		Improved pig farming			Local pig farming		
		n	Percentage	CI	*n*	Percentage	CI
Moment of mating after estrus detection	Immediately	39	28.2[b]	14.1	24	70.8[a]	18.2
	1–6 h	39	0.0[a]	0.0	24	8.3[a]	11.1
	6–12 h	39	0.0[a]	0.0	24	0.0[a]	0.0
	12–18 h	39	2.6[a]	5.0	24	0.0[a]	0.0
	18–24 h	39	15.4[a]	11.3	24	4.2[a]	8.0
	24–30 h	39	10.3[a]	9.5	24	12.5[a]	13.2
	30–36 h	39	5.1[a]	6.9	24	0.0[a]	0.0
	36–48 h	39	25.6[a]	13.7	24	4.2[b]	8.0
	48–72 h	39	41.0[a]	15.4	24	0.0[b]	0.0
Number of mating	Once	39	59.0[a]	15.4	24	50.0[a]	20.0
	Twice	39	28.2[a]	14.1	24	4.2[b]	8.0
	Estrus	39	15.4[b]	11.3	24	52.2[a]	20.0
Estrus lactation	Yes	39	18.0[a]	12.0	24	8.3[a]	11.1
	No	39	82.1[a]	12.0	24	91.7[a]	11.1
Pregnancy diagnosis	Yes	39	94.9[a]	6.9	24	95.8[a]	8.0
	No	39	5.1[a]	6.9	24	4.2[a]	8.0
Pregnancy diagnosis technique	Signs of estrus	38	79.5[a]	12.7	24	83.3[a]	14.9
	Using a boar	38	0.0[a]	0.0	24	8.3[a]	11.1
	Both	38	10.3[a]	9.5	24	4.2[a]	8.0
	Swollen breasts	38	10.3[a]	9.5	24	0.0[a]	0.0

The percentages of the same row followed by different letters differ significantly at the threshold of 5%

n number, *CI* confidence interval

same trend was observed for the number of piglets born alive and weaned piglets (Table 4). The stillborn number and birth-weaning dead number of piglets in local and improved sows' litters were not significantly different. The litter size at birth and the number of live-born piglets increased with the parity number until the fourth and subsequently dropped, regardless of the breed (Table 5). The piglets' stillborn number in a local sow litter was 0.2 ± 0.1 piglet on average and that in an improved sow litter was 0.1 ± 0.1 piglet. The size of stillborn piglets was influenced by the parity number. The largest numbers of stillborn were obtained at 5th parity for both breeds (Tables 5, 6). The mean of birth-weaning dead piglets was 1.4

Table 3 Reproductive animals' treatments and difficulties encountered in pig farms in the departments of Ouémé and Plateau

Variables		Improved pig farming			Local pig farming		
		n	Percentage	CI	*n*	Percentage	CI
Pregnant sow treatments	Parasite control	39	69.4[a]	14.5	24	8.3[b]	11.1
	Iron	39	82.1[a]	12.0	24	41.7[b]	19.7
	Vitamin	39	82.1[a]	12.0	24	62.5[b]	19.4
	Antibiotic	39	79.5[a]	12.7	24	70.8[a]	18.2
Nursing sow treatments	Parasite control	39	74.3[a]	13.7	24	75.0[a]	17.3
	Iron	39	79.5[a]	12.7	24	29.2[b]	18.2
	Vitamin	39	92.3[a]	8.4	24	79.2[a]	16.2
	Antibiotic	39	79.5[a]	12.7	24	50.0[b]	20.0
Piglets' treatments	Umbilical cord disinfection	39	7.7[a]	8.4	24	4.2[a]	8.0
	Teeth cutting	39	2.6[a]	5.0	24	0.0[a]	0.0
	Adoption	39	2.6[a]	5.0	24	4.2[a]	8.0
	Iron	39	100[a]	0.0	24	95.8[a]	8.0
Encountered difficulties	Late estrus after weaning	35	51.4[a]	16.6	24	4.2[b]	8.0
	Mating failure	35	28.6[a]	15.0	24	41.7[a]	19.7
	Agalactia	35	8.6[a]	9.3	24	4.2[a]	8.0
	Tail biting	35	11.4[a]	10.5	24	0.0[a]	0.0
	Piglets crushing	35	28.6[a]	15.0	24	33.3[a]	18.9
	Anemia	35	80.0[a]	13.3	24	16.7[b]	14.9
	Dead birth	35	45.7[a]	16.5	24	50.0[a]	20.0

[a,b] The percentages of the same row followed by different letters differ significantly at the threshold 5% (farming method effect)

n number, *CI* confidence interval

Table 4 Reproductive performances of local and improved breeds

Variables	Improved breed			Local breed			Significance
	n	Mean	SE	*n*	Mean	SE	
Litter size at birth	166	8.9	0.5	53	6.3	0.4	***
Live-born piglets	166	8.8	0.5	53	6.1	0.4	***
Stillborn piglets	166	0.1	0.1	53	0.2	0.1	NS
Birth-weaning dead piglets	166	1.4	0.3	53	1.0	0.2	NS
Litter size at weaning	166	7.4	0.5	53	5.1	0.4	***
Gestation length (days)	51	114.4	0.1	8	114.1	0.4	NS
Age at weaning (days)	63	43.7	0.4	17	52.8	0.8	***
Age at first mating (days)	7	253.6	9.7	8	242.5	9.1	NS
Age at first farrowing (days)	7	368.6	9.7	8	356.5	9.1	NS
Farrowing interval (days)	10	175.2	4.9	5	201.4	6.9	**
Weaning-mating interval (days)	10	16.8	4.1	2	34.0	9.3	NS

SE standard error

NS: $P > 0.05$

***$P < 0.001$

piglets per improved sow litter and 1 piglets per local sow litter. The size of birth-weaning dead piglets in the first parity was higher than that in the second parity whatever of the genetic type. From the second parity, the size of birth-weaning dead piglets increased with the parity number until the 5th parity (Table 5). The number of weaned piglets per litter was significantly higher ($P < 0.001$) in the improved breed (7.4 vs 5.1 piglets). This number increased with the parity number until the 4th parity and decreased thereafter (Table 5). The rate of live-born piglets, stillborn piglets, birth-weaning dead piglets, and weaned piglets did not vary significantly from one breed to another (Table 7). These rates also did not vary significantly from one parity number to another (Table 6).

The litter size of improved and local sows was highly and significantly correlated with the size of live-born piglets on the one hand ($0.96 < r < 0.99$, $P < 0.001$) and with the mean of weaned piglets on the other hand (0.79 ± 0.86, $P < 0.001$). The correlations between the number of birth-weaning dead piglets of improved pigs and the litter size and the number of live-born piglets were lower but highly significant ($r < 0.28$, $P < 0.001$). On the contrary, these correlations were not significant in local pigs (Table 8). In improved pigs, the number of stillborn piglets was not significantly correlated with any of

Table 5 Effect of farrowing rank on reproductive performances of local and improved sows

Variables	Improved breed						Local breed						RMSE	ANOVA
	Parity 1 (*n* = 77)	Parity 2 (*n* = 51)	Parity 3 (*n* = 23)	Parity 4 (*n* = 11)	Parity 5 (*n* = 3)	Parity ≥ 6 (N = 1)	Parity 1 (*n* = 13)	Parity 2 (*n* = 12)	Parity 3 (*n* = 9)	Parity 4 (n = 5)	Parity 5 (*n* = 5)	Parity ≥ 6 (*n* = 10)		
Litter size at birth	8.0^{cde}	8.9^{bd}	9.5^{abd}	10.8^{a}	7.3^{def}	9^{abcdef}	5.1^{f}	5.8^{f}	6.7^{ef}	7.7^{def}	6.6^{ef}	6.0^{f}	2.5	**
Number of piglets born alive	7.9^{cde}	8.8^{bcd}	9.5^{abd}	10.8^{a}	7.0^{def}	9^{abcdef}	5.1^{f}	5.8^{f}	6.2^{ef}	7.7^{def}	6.0^{ef}	5.8^{f}	2.5	*
Stillborn piglets	0.1^{bc}	0.1^{bc}	0.0^{bc}	0.0^{bc}	0.3^{abc}	0.0^{c}	0.0^{bc}	0.0^{bc}	0.4^{ac}	0.0^{bc}	0.6^{ac}	0.2^{abc}	0.4	*
Birth-weaning dead piglets	0.8^{a}	0.6^{a}	1.2^{a}	1.5^{a}	0.3^{a}	4.0^{a}	0.9^{a}	0.7^{a}	1.0^{a}	1.2^{a}	1.4^{a}	0.9^{a}	1.4	NS
Litter size at weaning	7.1^{bce}	8.2^{ace}	8.3^{ace}	9.3^{ace}	6.7^{cdef}	5.0^{ef}	4.2^{f}	5.2^{def}	5.2^{def}	6.5^{cdef}	4.6^{f}	4.9^{f}	2.6	*

Means of the same row followed by different letters differ significantly at the threshold of 5% (rank farrowing effect)

RMSE root mean square error

NS: $P > 0.05$

*$P < 0.05$; **$P < 0.01$

Table 6 Effect of farrowing rank on reproductive performances of local and improved sows (rates)

Variables	Improved breed						Local breed					
	Parity 1 (n = 77)	Parity 2 (n = 51)	Parity 3 (n = 23)	Parity 4 (n = 11)	Parity 5 (n = 3)	Parity ≥ 6 (n = 1)	Parity 1 (n = 13)	Parity 2 (n = 12)	Parity 3 (n = 9)	Parity 4 (n = 5)	Parity 5 (n = 5)	Parity ≥ 6 (n = 10)
Number of piglets born alive	99.0 ± 2.2^{a}	98.5 ± 3.4^{a}	100 ± 0^{a}	100 ± 0^{a}	95.4 ± 23.6^{a}	100 ± 0^{a}	100 ± 0^{a}	100 ± 0^{a}	93.3 ± 16.3^{a}	100 ± 0^{a}	90.9 ± 25.2^{a}	96.7 ± 11.1^{a}
Stillborn piglets	1.0 ± 2.2^{a}	1.5 ± 3.4^{a}	0^{a}	0^{a}	4.6 ± 23.6^{a}	0^{a}	0^{a}	0^{a}	6.7 ± 16.3^{a}	0^{a}	9.1 ± 25.2^{a}	3.3 ± 11.1^{a}
Birth-weaning dead piglets	10.1 ± 6.8^{a}	6.9 ± 6.9^{a}	12.4 ± 13.5^{a}	14.3 ± 20.7^{a}	4.8 ± 24.1^{a}	44.4 ± 97.4^{a}	17.9 ± 20.8^{a}	11.4 ± 18^{a}	16.1 ± 24^{a}	16.1 ± 32.2^{a}	23.3 ± 37.1^{a}	15.5 ± 22.4^{a}
Piglets born alive	89.9 ± 6.8^{a}	93.1 ± 6.9^{a}	87.6 ± 13.5^{a}	85.7 ± 20.7^{a}	95.2 ± 24.1^{a}	55.6 ± 97.4^{a}	83.1 ± 20.8^{a}	88.6 ± 18^{a}	83.9 ± 24^{a}	83.9 ± 32.2^{a}	76.7 ± 37.1^{a}	84.5 ± 22.4^{a}

The rates of the same row followed by same letters do not differ significantly at the threshold of 5%

the recorded parameters. In local pigs, this number was lowly and significantly correlated with the litter size. The correlation between the size of birth-weaning dead piglets and the number of local weaned piglets was negative and highly significant. The number of live-born piglets of local and improved pigs was highly and significantly correlated with the size of weaned piglets ($0.82 < r < 0.87$, $P < 0.001$). The average of gestation length was 114 days and did not vary significantly from one breed to another. In contrast, improved piglets were weaned earlier ($P < 0.001$) than local pigs (43.7 vs 52.8 days). The farrowing interval was significantly longer in local sows (201.4 days) than in improved sows (175.2 days). The age at the first mating was 253.6 days for improved gilts and 242.5 days for local gilts. The age at the first farrowing was 368.6 days for improved sows and 356.5 days for local sows. The weaning-mating interval was 16.8 and 34 days, respectively, for improved and local sows.

Growth performances

The weights from birth to 2 months of age of improved piglets were numerically greater ($P < 0.001$) than those of local pigs (Table 9). Thus, the birth weight of an improved piglet was 1.1 kg against 0.6 kg for a local piglet. At 1 month, this weight increased to 4.8 kg for the improved piglet and 1.8 kg for the piglet. Finally, at 2 months of age, the improved piglet weighed 7.3 kg and the local piglet 1.8 kg. Sex has no influence on weights at standard age within each breed. In contrast, weights at different ages of improved female and male piglets were significantly higher than those of local female and male piglets (Table 10).

Discussion

Reproduction management in farms

To detect the estrus, the breeders refer to the color and the aspect of the vulva and the overlap of both of them. The pig breeders do not have enough knowledge on the estrus signs because they did not know that the most evocative sign of estrus is the reflex of immobility (Feller et al. 2004; Aladi et al. 2008; IFIP 2013; Leborgne et al. 2013). This sign is very less used by breeders. Breeders do not observe this sign also because they do not use the boar for estrus detection. Thus, the boar arouses a receptive and favorable behavior expression because the sow responds strongly to the boar stimuli (Feller et al. 2004). Breeders should also have an estrus detection schedule after weaning to avoid unnoticed estrus. The mating period needs to be improved by breeders because mating before 10 h after the estrus onset may result in mating failure or small litters (IFIP 2013). It is the same for late mating. Indeed, the ovulation occurs 30 to 40 h after the onset standing estrus

Table 7 Reproductive performances of local and improved breeds (rates)

Variables	Improved breed ($n = 166$)		Local breed ($n = 53$)	
	Rate (%)	Confidence interval	Rate (%)	Confidence interval
Piglets born alive	99.0a	1.5	97.2a	4.4
Stillborn piglets	0.9a	1.5	2.8a	4.4
Birth-weaning dead piglets	9.9a	4.5	16.0a	9.9
Weaned piglets number	90.1a	4.5	83.9a	9.9

The rates of the same row followed by the same letters do not differ significantly at the threshold of 5%

and the mating should be performed 12 to 24 h before ovulation (Leborgne et al. 2013). The lack of mastery of estrus detection justifies the early and late mating by breeders. These early and late matings would justify the mating failures registered by some breeders. This is why local pig breeders who have little control of estrus signs prefer to leave the boar with the sow during the estral period. In order to have good prolificacy and fertility, two matings are recommended for a detected estrus (IFIP 2013; Helke et al. 2015; Knox 2016) instead of one mating performed by most of the breeders. The problem of late estrus after weaning is due to the lactation, which is very long. The average lactation duration in this study is 43.7 ± 0.4 days for improved sows and 52.8 ± 0.8 days for local sows. Decreasing the suction intensity during this period may cause prolactin drop, resulting in the lactation estruses responsible for shift or lengthening of the weaning-estrus interval after weaning (IFIP 2013). A poor sow's feeding can also cause late estrus after weaning due to the mobilization of body reserves for milk production for piglets (IFIP 2013; Spinka and Illmann 2015). Local pig breeders who provide care to pregnant and lactating sows are generally below those of improved pigs because local pigs are more resistant to disease. The anemias encountered by improved pig breeders are common in pigs and are due to an iron lack in the sow's milk (Leborgne et al. 2013; Pommellet et al. 2014; Perri et al. 2015). This problem is corrected by the iron administration to piglets between 3 and 4 days after farrowing. This treatment is essential because anemic piglets have a slow growth rate (Perri et al. 2015). Breeders must also have in farms security systems in the lodges in order to limit piglets crushing by the sow.

Reproductive performances of improved and local pigs

The litter size of improved sows was significantly higher than that of local sows. Similar trends were reported by Youssao et al. (2009b) in Benin and Kouamo et al. (2015) in Cameroon where local sows' litter size was lower than that of exotic sows (Landrace, Large White, and Duroc). The litter size of 6 piglets of local sows is also reported in pig farms in Benin (Youssao et al. 2008; Kouthinhouin et al. 2009). Higher litters of 7 to 9 piglets were reported in improved breeding in Benin, Ghana, and Cameroon for local sows (Abdul-Rahman et al. 2016; Kouamo et al. 2015; Kouthinhouin et al. 2009; Youssao et al. 2009a, 2009b). The differences between our values and those of these authors are related to the animal management modes. Thus, most of these authors' studies were carried out at the station or controlled breeding while the performances in our study were recorded directly on farms. The litter size increases with the parity number until the 4th parity. Many studies report a minimum litter size at parity 1, attaining a maximum at parities 3, 4, and 5 (Aubry et al. 2001; Quesnel et al. 2008). Besides, the litter size influences the birth weight and the piglets' growth. The increase in prolificacy has been accompanied over time by a decrease in the piglets' mean weight and an increase in the heterogeneity between the litter piglets (Quiniou 2010; Tribout et al. 2003). The parity

Table 8 Correlations between improved (above diagonal) and local (below diagonal) reproductive performances

	Litter size at birth	Number of piglets born alive	Stillborn piglets	Birth-weaning dead piglets	Litter size at weaning
Litter size at birth	1	0.99***	0.02^{NS}	0.28***	0.86***
Number of piglets born alive	0.96***	1	-0.10^{NS}	0.28***	0.87***
Stillborn piglets	0.33*	0.06^{NS}	1	0.01^{NS}	-0.11^{NS}
Birth-weaning dead piglets	0.02^{NS}	0.01^{NS}	0.01^{NS}	1	−0.23**
Litter size at weaning	0.79***	0.82***	0.04^{NS}	−0.55***	1

NS: $P > 0.05$

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

Table 9 Effect of breed on growth performances of pigs

Variable	Improved breed			Local breed			ANOVA
	n	Mean	Standard error	*n*	Mean	Standard error	
W0 (kg)	152	1.1	0.0	52	0.6	0.1	***
W1(kg)	214	4.8	0.1	52	1.8	0.2	***
W2 (kg)	136	7.3	0.1	52	2.8	0.2	***

W*i*: weight at *i* month of age; ***$P < 0.001$

number, litter size, and piglet growth are parameters to be studied together for a better appreciation of the sow's numerical and weight productivity. The number of live-born piglets and the number of weaned piglets follow the same trend as the litter size and justify the choice of the fourth parity as the parity number from which the sows are reformed in these two department farms (Dotché et al. 2018). The number of stillborn piglets and the number of birth-weaning dead piglets are not influenced by the genetic type. This fact was observed between local breed, Large White pigs and their products in Benin (Youssao et al. 2009b).

The gestation length of improved and local sows was 114 days and is consistent with the normal gestation length of sows, which is 114–115 days (Helke et al. 2015). Shorter durations of 111 days were reported in Nigeria for local breed (Nwakpu and Onu 2011). The gestation length is not influenced by the genetic type. On the contrary, Ncube et al. (2003) reported shorter gestation length (113 days) with local sows than that with Large White (118 days) in Zimbabwe. The first mating age and the first farrowing age are not influenced by the genetic type (Kouamo et al. 2015) in Douala.

The interval between two farrowing of 201.4 days for local sows is similar to 202.7 days reported by Kouamo et al. (2015) in Cameroon for the same breed. Similarly, the interval between farrowing of 175.2 days for improved sows is similar to an average interval of 174.1 days of Landrace, Large White, and Duroc sows reported by Kouamo et al. (2015) in Cameroon. Contrary to our study, where local sows showed a larger farrowing interval, Kouamo et al. (2015) did not report genetic type effect on this interval even though our values are very close. The lack of genetic type effect reported by Kouamo et al. (2015) would be due to the reduced number of local sows in their study ($n = 2$). Improved piglets were weaned earlier (44 days) than local pigs (53 days) because they grow faster. The weaning age of local piglets is lower than the age of 62 days reported by Youssao et al. (2009a) in the same genetic type but more than 50 days reported by Kouthinhouin et al. (2009) in improved breeding. The age variations at weaning of local piglets would be linked to the influence of rearing mode, feeds, and season on piglet growth. Thus, even if the animals are reared in an improved mode in all the farms, the food used and the health monitoring are not same. In addition, during hot weather, the food consumption decreases with negative effects on milk production, leading to a decline in the piglets' growth (Fortun-Lamothe et al. 2014; Gourdine et al. 2005; Renaudeau et al. 2003). Moreover, Kouthinhouin et al. (2009) reported an earlier weaning in improved breeding than in traditional breeding of local piglets. The weaning-fertilizing mating interval of 34 days in local sows is long and is a consequence of the long breastfeeding duration.

The litter size, the number of live-born piglets, and the number of weaned piglets are highly correlated variables whatever the genetic type. This means that the larger is the litter size, the better the breeder has live-born and weaned piglets. The high correlations between these variables were reported by Bouquet et al. (2006) and Nielsen et al. (2013) in Landrace and Large White pigs. These authors also reported low correlations between these variables and the number of piglets born dead and the farrowing-weaning death number as

Table 10 Effect of breed-sex interaction on pigs' growth performances

Variable	Improved breed				Local breed				RMSE	ANOVA
	Male		Female		Male		Female			
	n	Mean	*n*	Mean	*n*	Mean	*n*	Mean		
W0 (kg)	80	1.1^a	72	1.1^a	25	0.6^b	27	0.6^b	0.2	*
W1 (kg)	113	4.8^a	101	4.8^a	25	1.8^b	27	1.7^b	1.4	*
W2 (kg)	66	7.3^a	70	7.4^a	25	2.9^b	27	2.7^b	1.7	**

W*i*: weight at *i* month of age; the means of the same row followed by different letters differ significantly at the threshold of 5%. RMSE Root Mean Square Error

*$P < 0.05$; **$P < 0.01$

observed in this study. The strategies for litter size improvement at the birth, such as practice improvement (habitat, food and health monitoring) (Kouthinhouin et al. 2009), should be encouraged. Selection also improves litter size, even if the litter size heritability is low ($h^2 = 0.10$) (Nielsen et al. 2013). However, the increase of litter size should be done with caution since birth-weaning mortalities are often high in large litter size because competitions between piglets for teats are high and result in the weakest piglets' death (Andersen et al. 2011). Therefore, a litter size improvement accompanied by a selection on the birth weight would be preferable in order to obtain more heavy piglets at weaning.

Growth performances of improved and local piglets

The birth weight was influenced by the genetic type and improved piglets showed the best weight. The presence of the genetic type effect on the piglets' birth weight has already been reported by Youssao et al. (2009b) in Benin and Aladi et al. (2008) in Nigeria. These authors reported a higher weight for Large White piglets than local piglets at birth. This genetic type effect noticed at birth is observed up to 4 months and shows that improved piglets have a faster growth rate than local piglets. The growth improvement of the local piglets by the genetic type was reported by Youssao et al. (2009b). In addition to the genetic type, improved breeding conditions also improve the weight of local piglets after farrowing (Kouthinhouin et al. 2009). The weight of males was not significantly different from that of females within each genetic type in this study. This remark confirms the observations of Kouthinhouin et al. (2009) who found no sex effect on piglet weight from birth to 8 weeks of age. Youssao et al. (2009b) and Oluwole and Omitogun (2015) also did not report the sex effect on local and improved piglets' weights from birth to weaning. It therefore appears that male and female piglets do not have different weights from birth to weaning.

Conclusion

The study on the comparison of reproductive performances of pigs reared in south Benin showed that reproductive performance varies between the two genetic types studied and the best performances were obtained with improved pigs. The sex does not influence the weights at standard age within each genetic type studied. The litter size, the number of live-born piglets, and the number of weaned piglets increase with the parity number until the fourth parity. The estrus signs were mainly those of vulvar changes and overlapping of other females. The mating period after estrus detection was diversified in improved pig farming while mating occurred once estrus is detected in the local pig farming. Whatever genetic type, pregnancy diagnosis is practiced 21 days after mating by the control of return of estrus.

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Compliance with ethical standards

Statement of animal right The manuscript does not contain clinical studies or patient data.

Conflict of interest The authors declare that they have no conflict of interest.

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