



Comparison of the reproductive performances of local pigs, improved pigs and the products of their crossbreeding with stress-negative Piétrain pigs

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ABSTRACT

The reproductive performance of pig breeds reared in Benin is inferior to that of exotic breeds. The aim of this study was to assess the impact of crossbreeding between locally-reared pig and the Piétrain on female reproductive performance. A total of five batches, each comprising 12 females, were created. The first group consisted of local gilts, the second of Local-Piétrain crossbred gilts, the third of Piétrain gilts, the fourth of improved-Piétrain crossbred gilts, and the fifth of improved gilts. The females in the first and fifth batches were mated with a local and an improved boar, respectively, while those in the other three batches were inseminated with Piétrain semen. The reproductive performance of the sows from each batch was recorded and analyzed. The results indicated that the number of live births, litter size at birth, and weaning of Piétrains and F1 females was higher than that of local sows. The rate of stillbirths was markedly elevated in Piétrain litters in comparison to those of local and F1 sows. The gestation length was found to be longer in Piétrain sows (118.66 days) than in local sows (114.3 days) and F1 females (112.75 days). The litter weight at birth and weaning of F1 piglets was significantly higher than that of local piglets. The results of the crossbreeding trials involving the improved breed did not reveal any significant variations. In sum, crossbreeding between the local breed and Piétrain improves the reproductive performance of the animals.

Keywords: Pig, Reproductive performance, Republic of Benin, Stress Negative Piétrain

Pig farming in Benin is typified by the coexistence of two distinct genetic types: local pigs and pigs of improved breeds. The term “improved-breed pigs” encompasses both exotic breeds (a mixture of Large White, Landrace, Duroc breeds) and products obtained by crossbreeding between the exotic breeds (Youssao *et al.* 2018). The animals in question have a length of approximately 79 cm and are predominantly white in color, displaying a variety of patterns. The head is characterized by a concave profile and terminates in a short, cylindrical snout. The ears are predominantly erect and directed forward (Youssao *et al.* 2018). The local type of pig is a small animal, with an average length of 52.2 cm. The coat is white or black with uniform patterns. The ears are mostly erect (Youssao *et al.* 2018). Additionally, there are products resulting from crosses between these two groups (Youssao *et al.* 2018, Dotché *et al.* 2019).

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Each genetic type possesses distinctive qualities and deficiencies, necessitating the identification of solutions to enhance the breed's overall efficiency. The local breed is distinguished by its resilience to disease and its capacity to thrive in challenging rearing environments (Youssao *et al.* 2008, Agbokounou *et al.* 2016). The primary limitation of the local pig breed is its relatively low weight and poor numerical performance. The average litter size of local pigs is 6.3 piglets, with an average weaning size of 5.1 piglets (Dotché *et al.* 2020). The quality of the improved pigs is evidenced by their superior performance, which is demonstrably superior to that of local pigs (Dotché *et al.* 2020). The litter size at birth of this pig genotype is 8.9 piglets, while the litter size at weaning is 7.4 piglets (Dotché *et al.* 2020). One disadvantage of the improved pig is that it has a high fat content, which may limit its consumption (Ganiero 2019). The cross-breeding of the improved breed, notably the Large White, with local pigs has been shown to enhance zootechnical performance (Youssao *et al.* 2009, Dotché *et al.* 2019). The current challenge for pig farms in Benin is to identify a breed that would enhance the zootechnical performance of local pigs while preventing the accumulation of adipose tissue and reducing the fat content in the meat. The Piétrain breed,

of Belgian origin, is distinguished by a markedly high yield of lean meat (exceeding 83%) and an aptitude for enhancing carcass quality in accordance with the demands of the lean pork market (Youssao *et al.* 2002, Gispert *et al.* 2007). It may, therefore, be employed to address the deficiencies inherent to pigs reared in Benin. In addition to carcass quality, this breed exhibits promising zootechnical performance, including good growth and acceptable numerical productivity (Sourdioux *et al.* 2009, Lebreton *et al.* 2023). This study aims to assess the impact of crossbreeding pigs raised in Benin with the Stress-negative Pietrain breed on female reproductive performance.

MATERIALS AND METHODS

Study area: The study was conducted at two distinct pig farms: the Pig Farm of the Department of Animal Production of the Faculty of Agronomic Sciences and the Pig Farm of the Laboratory of Animal Biotechnology and Meat Technology (LBATV) of the Department of Animal Production and Health of the Polytechnic School of Abomey-Calavi. Both farms are located at the University of Abomey-Calavi. The University of Abomey-Calavi is situated in the Atlantic Department, in the southern region of Benin. The region benefits from a sub-equatorial climate, characterized by two distinct rainy seasons: the long season (April to July) and the short season (October to November). These two seasons are interspersed with dry seasons, the longest of which occurs between December and March. The temperature range is relatively narrow, with an average of 25 to 30 degrees Celsius, and the annual precipitation varies between 900 and 1,500 mm.

Animals and breeding methods: The animal material comprises local, improved, and Stress-Negative Pietrain pigs, all of which are 8.5 months old. The local pigs used in this study were born at the pig farm of the Department of Animal Production of the Faculty of Agronomic Sciences and came from parents selected from private farms in the commune of Ifangni in southern Benin. The improved pigs were born and reared at the LBATV piggery and originated from parents selected from private farms in the commune of Sème-Podji in southern Benin. The improved breed represents animals of exotic breeds (a mixture of Large White, Landrace, Duroc breeds) and the products of their crossbreeding (Youssao *et al.* 2018). With regard to the Pietrains utilized in the present study, they were born and reared at the LBATV piggery and came from parents imported from Belgium.

The reproducers from all three genotypes were housed in buildings with modern hard-standing facilities, including feeders and drinkers. The lactating sows were provided with a diet consisting of the following ingredients: wheat bran, corn bran, palm kernel meals, soybean meal, oyster shell, salt, and lysine. The metabolizable energy of the feed was 3000 kcal/kg of feed, and it contained 18% total nitrogenous matter. The quantity of feed provided was 4 kg per day per lactating sow. Water was supplied *ad libitum*. Animals from different batches received the same

feed formulas and care. Each sow raised male and female piglets in the same pen until weaning at 6 weeks of age. An iron injection was administered to piglets on the third day after farrowing to prevent the onset of anaemia.

Experimental design: Five distinct groups of gilts were created. The first group of pigs comprised 12 local gilts, the second group 12 crossbred gilts with local sows and Pietrain boars, the third group 12 Pietrain gilts, the fourth group 12 crossbred gilts with improved sows and Pietrain boars, and the fifth group 12 improved gilts. The first batch was mated with local breed boars, while the fifth was mated with improved breed boars. The females in the second, third, and fourth batches were inseminated with semen from the Pietrain. Each female was inseminated on two occasions, with an interval of 12 hours between each instance. The initial insemination procedure was conducted 12 hours following the onset of estrus. Local sow x Pietrain boar gilts were obtained through the crossbreeding of a local sow with a Pietrain boar. Similarly, the improved sow-Pietrain boar cross females result from a crossbreeding between the improved sow and the Pietrain boar. The crossbreeding was conducted at the research facility prior to the commencement of the study.

Data collection: The data on the insemination procedures and the reproductive parameters are duly recorded. The data set includes information on the date of mating or insemination, the farrowing date, the number of piglets born alive, the number of stillbirths, the number of piglets at weaning, and the weight of a piglet at birth and weaning. The aforementioned data were employed to ascertain the length of gestation, the viability of piglets, the size of litters at birth and weaning, and the number of deaths occurring between birth and weaning. Piglet weights at birth and at weaning were recorded individually using an electronic scale from the manufacturer WeiHeng (Guangzhou, Guangdong Province, China), which has a maximum capacity of 50 kg and the accuracy of ± 5 g.

The rates of live-born, stillborn, birth-weaning mortality, and weaned piglets were determined using the following formulas:

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

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

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

$$\text{Pre-weaning survival rate} = \frac{(\text{Weaned number})}{(\text{Total number of piglets born})} \times 100$$

Statistical analysis: In order to analyze the data pertaining to reproductive performance, a fixed-effects linear model was adjusted for the performance data collected (litter size, number of live births, number of stillbirths, gestation length, litter weight at birth and at weaning) and included the fixed effect of genetic type. The fixed effect of genetic

Table 1. Influence of crossbreeding on the reproductive performance of local pigs

Variable	Pietrain (N=12)	Local (N=12)	Pietrain * Local (N=12)	SEM	p value
Litter size at birth	8.42 ^a	5.70 ^b	7.75 ^a	0.83	<.0001
Live-born Piglets	8.00 ^a	5.70 ^b	7.75 ^a	0.89	<.0001
Stillborn Piglets	0.41 ^a	0.00 ^b	0.00 ^b	0.31	0.003
Birth-weaning dead piglets	0.66	0.40	0.75	0.83	0.601
Litter size at weaning	7.33 ^a	5.30 ^b	7.00 ^a	0.93	<.0001
Gestation length (days)	118.7 ^a	114.3 ^b	112.7 ^c	1.00	<.0001
Litter weight at birth (kg)	11.2 ^a	4.27 ^c	8.50 ^b	0.94	<.0001
Litter weight at weaning (kg)	73.8 ^a	27.2 ^c	53.9 ^b	4.91	<.0001

^{abc}The means of the same row followed by different letters differ significantly at the threshold of 5%, SEM: Standard error of mean

Table 2. Live born rate, stillborn rate, death rate between birth and weaning, weaning rate of Pietrain, local and F1 piglets.

Variable	Pietrain (N=12)		Local (N=12)		Pietrain * Local (N=12)	
	%	CI	%	CI	%	CI
Piglets born alive	95.1 ^a	12.3	100 ^a	0.00	100 ^a	0.00
Stillborn piglets	4.95 ^a	12.3	0.00 ^a	0.00	0.00 ^a	0.00
Birth-weaning dead piglets	8.33 ^a	15.6	7.02 ^a	14.5	9.68 ^a	16.7
Pre-weaning survival rate	91.7 ^a	15.6	92.9 ^a	14.5	90.3 ^a	16.7

CI: Confidence interval, ^{abc}The rates of the same row followed by same letters do not differ significantly at the threshold of 5%.

type was also included in the model, which is presented in the following form:

$$Y_{ik} = \mu + T_i + \varepsilon_{ik}$$

where,

Y_{ik} : the reproductive performance of pig k, of genetic type i

μ : the value of the overall average

T_i : fixed effect of genetic type i (local pigs, improved pigs, Stress-Negative Pietrain pigs, crosses between Pietrain and local pigs, crosses between Pietrain and improved pigs)

ε_{ik} : random residual effect

The Generalized Linear Model (Proc GLM) procedure in SAS (2013) was employed for the analysis of variance, and the means were subsequently calculated and compared via a t-test.

The disparate rates were then subjected to a two-tailed Z-test, which enabled a comparison between each pair

of rates. For each relative frequency, a 95% confidence interval (CI) was calculated using the following formula:

$$CI = 1,96\sqrt{([P(1-P)]/N)}$$

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

RESULTS AND DISCUSSION

Influence of crossbreeding on reproductive performance of local pigs: Litter size at birth and weaning, number of live births, number of stillborn, gestation length, litter weight at birth and weaning varied by genetic type (Table 1). The number of live born, litter size at birth and weaning of Pietrains and F1 females were significantly higher ($p<0.01$) than those of local sows. There were more ($p<0.01$) stillborn piglets in Pietrain litters than in those of local and F1 sows. Gestation length was longer ($p<0.001$) in Pietrain sows (118.66 days) than in local sows (114.3 days) and F1 females (112.75 days). Gestation length was also longer in the local sow than in the F1 female ($p<0.05$). Litter weight at birth and weaning of Pietrains piglets was higher ($p<0.001$) than that of local piglets and piglets from F1. Litter weight at birth and weaning of F1 piglets was significantly higher ($p<0.05$) than that of local piglets. The live born rate, stillborn rate, mortality rate between birth and weaning, weaning rate did not differ significantly among genetic types (Table 2).

Influence of crossbreeding on the reproductive performance of improved pigs: Most reproductive parameters did not vary between genetic types, except for gestation length, which was significantly longer ($p<0.001$) in Pietrains (118.67 days) than in the improved breed

Table 3. Influence of crossbreeding on the reproductive performance of improved pigs

Variable	Pietrain (N=12)	Improved (N=12)	Pietrain * Improved (N=12)	SEM	p-value
Litter size at birth	8.42 ^a	9.29 ^a	9.12 ^a	1.86	0.55
Live-born Piglets	8.00 ^a	9.29 ^a	8.75 ^a	1.81	0.33
Stillborn Piglets	0.42 ^a	0.00 ^a	0.37 ^a	0.53	0.25
Birth-weaning dead piglets	0.67 ^a	0.57 ^a	0.12 ^a	0.80	0.33
Litter size at weaning	7.33 ^a	8.71 ^a	8.62 ^a	1.77	0.14
Gestation length (days)	118.7 ^a	115.3 ^b	115.7 ^b	1.20	<.0001
Litter weight at birth (kg)	11.2 ^a	10.7 ^a	12.6 ^a	1.82	0.12
Litter weight at weaning (kg)	73.8 ^a	63.7 ^a	58.1 ^a	12.1	0.06

^{abc}The means of the same row followed by different letters differ significantly at the threshold of 5%.

Table 4. Live born rate, stillborn rate, death rate between birth and weaning, weaning rate of Pietrain, local and F1 piglets

Variable	Pietrain (N=12)		Improved (N=12)		Pietrain *Improved (N=12)	
	%	CI	%	CI	%	CI
Piglets born alive	95.1 ^a	12.3	100 ^a	0.00	96.4 ^a	10.5
Stillborn piglets	4.95 ^a	12.3	0.00 ^a	0.00	3.57 ^a	10.5
Birth-weaning dead piglets	8.33 ^a	15.6	6.15 ^a	13.6	1.85 ^a	7.62
Pre-weaning survival rate	91.7 ^a	15.6	93.8 ^a	13.6	98.2 ^a	7.62

CI: Confidence interval, ^{abc}The rates of the same row followed by same letters do not differ significantly at the threshold of 5%.

(115.33 days) and F1 (115.75 days). Trends showed that litter size at birth and weaning, number of live born, were higher in improved pigs, lower in Pietrains and intermediate in crossbreeds. As for litter weight at birth and weaning, trends showed a higher weight in Pietrain. Live born rate, stillborn rate, mortality from birth to weaning and weaning rate did not differ significantly among genetic types (Table 3, 4).

Litter size at birth, number of live births and number of weaned pigs varied significantly according to the genetic types involved in the cross between the local sow and the Pietrain boar. The influence of genetic type on these parameters has already been reported in Benin following crossbreeding between local pigs and Large White (Youssao *et al.* 2009) and between local pigs and improved pigs (Dotché *et al.* 2019). The same effect was obtained in Nigeria after crossbreeding between Nigerian Ingenious pigs and exotic pigs, especially Large White and Landrace (Nwakpu and Onu 2011, Nwakpu 2013, Oluwole *et al.* 2014, Ologbose 2021). Similar to the present study, the above studies conducted in Benin and Nigeria reported higher reproductive performance of crossbred pigs than indigenous pigs, indicating that crossbreeding has improved their performance.

The Pietrain breed, which is used for improving other breeds, demonstrated superior performance on these parameters. In contrast, this breed demonstrated a higher incidence of stillbirths than the local and crossbred breeds, suggesting a lower resistance of Pietrain piglets compared to the local and crossbred breeds. This phenomenon is observed in the majority of exotic breeds in Africa (Adeshinwa *et al.* 2024). The litter size at birth and at weaning in Pietrains is 8.42 and 7.33 piglets, respectively, which is comparable to the respective litter sizes at those stages of development observed in the same breed in Vietnam (Do Duc *et al.* 2012), which were 9.2 and 7.9 piglets. The minor discrepancies between the values observed in Benin and Vietnam may be attributed to variations in breeding practices. While numerical productivity exhibited variability following crossbreeding between local pigs and Pietrain, crossbreeding between the “improved” genotype pig and Pietrain did not result in any statistically significant

variation in litter size at birth and weaning. The absence of a crossbreeding effect may be attributed to the fact that the improved breed is also the result of multiple uncontrolled crossbreeding between exotic breeds, specifically Large White, Duroc, and Landrace (Youssao *et al.* 2018). This lack of effect may be perceived as disadvantageous from a performance aspect; however, it is satisfactory in terms of the study aim and farm needs. This lack of effect may not be perceived as advantageous from a performance standpoint. However, it is deemed satisfactory in view of the objective of the study and the requirements of the breeders. It is imperative for farmers to identify a breed that can effectively reduce the fat content in the meat of improved pigs without compromising their reproductive performance. Crossbreeding trials conducted between improved and Piétrain pigs have demonstrated a notable reduction in fat content in the meat of crossbreeds (Bankolé 2019). The findings of this study substantiate that the use of Piétrain on improved pigs does not adversely impact reproductive performance.

In regard to the weight performance of piglets, a variation in litter weight at birth and weaning was observed as a function of genetic type following crossbreeding between local pigs and Pietrain. This variation was also observed by Youssao *et al.* (2009) when they crossed local pigs with Large White in Benin, and by Ologbose (2021) in crossbreeding involving local breed, Large White, and Landrace pigs. The crossbreeds exhibited higher weights than the local pigs and lower weights than the Pietrains. The superiority of crossbreeds over locals can be attributed to two factors: firstly, the improver breed is heavier than the local breed (Leroy *et al.* 2012); secondly, the litter size is larger than that of crossbreeds.

The duration of gestation was found to be longer in Pietrains than in other genotypes. The longer gestation period than the 115 days classically known in pigs (Drion *et al.* 2005, Leborgne *et al.* 2013) may be associated with litter size (Nowak *et al.* 2020). Indeed, while a litter size of approximately eight piglets is sufficient to initiate farrowing before 115 days in local, crossbred, and improved pigs, it is inadequate for the Pietrain sow due to her substantial weight, which is sufficient to support the weight of gestation during this period. This effect of genotype on gestation length of pigs is also reported by Nowak *et al.* (2020). Moreover, Nowak *et al.* (2020) discovered that longer gestation periods were linked to elevated mortality rates at birth. The cause of this mortality is hypoxia (Pietruszka *et al.* 2020). Consequently, the superiority of gestation length in the Pietrain sow may also explain the higher incidence of stillbirths in this genotype.

In conclusion, the study on improving the reproductive performance of local and improved pigs by crossing with the negative-stress Pietrain suggests that there may be potential for significant improvements in litter size at birth and weaning, number of live births, and litter weight at birth and weaning. It should be noted that the extent of these improvements may vary depending on the specific breeds

involved in the cross breeding. The crossbreeding between the local breed and the Pietrain produces significant gains, while crossbreeding between the “improved” breed and the Pietrain does not yield the same results. It may therefore be suggested that Pietrain could be used to improve the reproductive performance of local pigs. If the improved breed already incorporates significant performance improvements, the results of this study suggest that farmers could consider using Pietrain in a terminal cross breeding on this breed, with the aim of reducing fat content without fearing a regression in performance. In view of these results, it would be beneficial to continue work on the carcass quality of crossbreeds, particularly crossbreeds between the improved genotype and Pietrain.

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