



Non-genetic effects on production performance of large white Yorkshire sows in India

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ABSTRACT

A study was conducted to evaluate the influence of non-genetic factors on production performance in pigs, including piglet body weight, litter size, and litter weight. A total of 180 farrowing records collected over a ten-year period (2014-2023) in Tamil Nadu, India were used for the analysis. The data were analyzed using the General Linear Model (GLM) procedure. The results showed that season and parity had a significant effect ($P < 0.01$) on the traits studied. The highest birth weight of piglets was observed during the North East Monsoon (NEM), followed by summer and the South West Monsoon (SWM) seasons. In contrast, the highest weaning weight was recorded during the South West Monsoon season, followed by summer, winter, and the North East Monsoon. An increasing trend in both birth weight and weaning weight was observed from the first to the seventh parity, with statistically significant differences among parities ($P < 0.01$). Similarly, higher weaning weights were recorded in the first three parities of the sow, likely to be due to the uniform birth weights of piglets within the litter. The highest litter weight was observed in the seventh parity, and a better growth rate was noted at weaning, with significant differences ($P < 0.01$). Although litter size showed some variation, it did not affect the litter size at weaning. It is suggested to breeding of sows at earlier than usual in favorable season and it can be maintained up to seventh parity or at the age of four years old

Keywords: Birth weight of piglets, Litter size, Litter weight, Swine

Pigs are domesticated animals and form an important occupation for tribal communities in rural areas across India, especially in the South-Central and North-Eastern regions (Mahak *et al.* 2020). According to the 20th Livestock Census of India, the pig population is about 9.06 million (BAHS, 2025). Non-genetic factors such as season and parity (age of the animal) influence reproductive performance. Seasonal factors, including temperature and daylight duration, directly affect pig production. Parity or age is related to the physiological status of the sow, with reproductive performance generally improving between the 3rd to 6th parities (Tantasuparuk *et al.* 2000; Tummaruk *et al.* 2000). The pork industry plays a crucial role in the global agricultural economy, and its dynamics are influenced by factors such as consumer preferences, health

trends, and trade policies. Pig products such as bacon, ham and sausages production are getting popularized (Matabane *et al.* 2018). Large White Yorkshire is a popular and highly prolific breed of pig in India, known for its good growth rates and adaptability. The revenue / profit of the pig industry principally depends on the number of piglets weaned per sow and birth weight and variation in litter weight which is decided by parity, litter size (Riddersholm *et al.* 2021). It is considered as most important economic trait in pig production (Koketsu *et al.* 2017) and is manifested by ovulation rate, early embryonic survival, foetal survival until and around farrowing (Lund *et al.* 2002).

The sow's prolificacy, is primarily determined by breed (Knecht *et al.* 2015), body condition (Beyga and Rekiel, 2010), and parity or age (Karpiesiuk *et al.* 2018) and litter size (Buthelezi *et al.* 2024). The reproductive performance and economic efficiency of pig herds mostly affected by season (Van Rensburg and Spencer, 2014). The physical health of sow is attributed by parity and age. As parity increases, so does the number of stillborn piglets with varied birth weights. Yuan *et al.* (2015) discovered that older or pluriparous sows with higher parity had less uniformity and more variation in birth weight in piglets, whereas primiparous sows had higher uniformity and high birth weight.

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Non-genetic factors greatly influence the growth and development of piglets. By managing these non-genetic factors effectively, farmers can enhance the growth and overall health of piglets, leading to better production outcomes. The preweaning mortality is also affected by non-genetic factors like season sex and parity (Buthelezi *et al.* 2024). During rainy season the bacterial load and higher humidity will cause higher mortality in preweaning period. (Venkataramanan *et al.* 2021) and needs to be monitored to maximize profits in pig farming by lowering losses. The variation in the birth weight of piglets within litter could affect the pre-weaning performance which also differs among parities (Wegner *et al.* 2016; Charneca *et al.* 2021; Segura *et al.* 2020).

MATERIALS AND METHODS

Location of the experiment and animal management:

Data were collected from the piggery unit of the Veterinary College and Research Institute at Livestock Farm Complex, Namakkal between January 2014 and December 2023. Namakkal is situated at an elevation of 404 meters above the mean ocean level in the northwest agro-climatic zone of Tamil Nadu, at 11.2 degrees North and 78.2 degrees East.

In this experiment 10-12 productive parent sows in each age group, from first to seventh parity, were kept in a farrowing pen for the final trimester and fed and watered with high-quality feed. All sows received critical care to facilitate farrowing, including caring for the newborn piglets. The farrowed sows were kept in separate farrowing enclosures until they were ready to be weaned after 42 days. Depending on their body condition and parity of the sow, the restricted quantity of feed is distributed with free access to nipple drinkers.

Parameters studied: The number of live births, the number of piglets that were weaned, the average birth weight, and the average weight at weaning were the reproductive parameters that were examined. The number of live born piglets, their birth weight, and the occurrence of stillbirth and mummified fetus were recorded as soon as the piglets were farrowed. The weaning body weight was measured after 42 days of lactation. The above metrics were measured on litters based on parity from 1st to 7th parity, as well as season, over the last ten years (2014-2023). The seasons are divided into four groups: winter (December-February), summer (March-May), south-west monsoon (June-August), and north-east monsoon (September-November). The piglets' weight was determined using an electronic scale.

Statistical analysis: The data on pig reproductive performance was analysed using least-squares analysis of variance using IBM SPSS Statistics 23.0 version (IBM 2023).

RESULTS AND DISCUSSION

The body weight, litter size and litter weight of piglets differed significantly ($p < 0.01$) at birth and weaning during the study period as per season and parity of the sows and

is depicted in the Table 1 and 2, respectively. Table 1 and 2 show the least-squares means for body weight at birth and during weaning. The body weight of piglets at weaning showed less significant difference ($p < 0.05$) by seasons. *Body weight at birth and weaning:* The piglets' birth weights varied significantly ($p < 0.01$) in the summer, SWM, and NEM, and less significantly ($p < 0.05$) in the SWM at weaning compared to the other seasons. The growth rate was better in SWM when compared to other season. The body weight of the piglets at birth and weaning differed significantly ($p < 0.01$) depending on the parity of the sows. Piglets' birth weight peaked in the third parity and persisted until the seventh, and from the first to the third parity, they weaned heavier than expected. The birth weight was lower at first parity compared to weaning weight where it had higher body weight as compensated by its excellent growth rate.

The findings indicated that the parity of the sow significantly ($p < 0.01$) influenced the birth weight, litter size and weaned piglets which can be attributed to the variable pre-parturition and post-parturition environments provided sows of different parities (Zindove *et al.* 2021). The higher birth in aged sows indicated decreased litter uniformity and may be resulting from aging - related decline in oocyte quality (Yuan *et al.* 2015).

According to Knecht *et al.* (2015), the birth weight and weaning weight of Landrace and Large White Yorkshire sows were significantly influenced by parity, season, and environmental conditions. Zindove *et al.* (2013) reported a larger birth weight range among littermates and poor birth weight of piglets in large litter numbers. The birth weight of piglets recorded higher body weight with no statistical difference from third to seventh parity and were similar to the findings of Lund *et al.* (2002). These findings were also supported by the findings of Quesnel *et al.* (2008) and Knecht *et al.* (2015), who reported physiologically immature that young sows, partition more nutrients towards their own growth as compared to foetuses, which results in lower birth weight. Hoving *et al.* (2011) had also found a similar response in sows at the third to fifth parity.

The first, second, and third parities had larger weaning weights, indicating that their post-natal growth rate was strong. The birth weight at first parity was lower (1.25 ± 0.017), which is consistent with Peters *et al.* (2010) findings. Additionally, the growth in body weight at weaning was higher, which is inversely connected with Smits *et al.* (2011). Similar to the fact that multiparous sows with higher parity produce piglets with less uniformity in body weight due to low quality of oocyte discharged from older sows but primiparous sows deliver piglets with uniformity in birth weight and give improved growth rate at weaning (Yuan *et al.* 2015). Therefore, depending on the quality of the oocyte produced, body weight gain at birth was higher and substantially less at weaning.

Litter weight at birth and weaning: The litter weight at birth was higher for multiparous sows (Pooja *et al.* 2024). The study found a significant difference ($p < 0.01$) between

Table 1. Least Mean square (\pm S.E) body weight (kg), litter weight (kg) and litter size (No.) of piglets in large white Yorkshire pigs

Effect	At birth				At Weaning			
	N*	Birth Weight	Litter weight	Litter size	N*	Weaning weight	Litter weight	Litter size
Overall mean	1341	1.28 \pm 0.007	10.49 \pm 0.073	8.23 \pm 0.057	1307	9.32 \pm 0.062	74.50 \pm 0.534	8.07 \pm 0.054
Year		**	**	**		**	**	**
2014	37	1.15 ^F \pm 0.031	10.68 ^C \pm 0.344	9.25 ^{AB} \pm 0.270	37	8.98 ^{CDE} \pm 0.289	81.70 ^{AB} \pm 2.501	9.25 ^A \pm 0.253
2015	213	1.29 ^{DEF} \pm 0.016	11.79 ^{CD} \pm 0.175	9.36 ^{CDE} \pm 0.137	203	10.91 ^A \pm 0.148	98.22 ^A \pm 1.281	9.09 ^C \pm 0.130
2016	191	1.29 ^{BCD} \pm 0.015	12.31 ^A \pm 0.171	9.45 ^{ABC} \pm 0.134	185	8.13 ^{DE} \pm 0.146	74.85 ^{BCD} \pm 1.266	9.12 ^{AB} \pm 0.128
2017	97	1.44 ^{BC} \pm 0.025	11.29 ^{BC} \pm 0.0278	8.10 ^{BCD} \pm 0.218	95	9.21 ^{DE} \pm 0.233	71.03 ^{DEF} \pm 0.020	7.91 ^{BC} \pm 0.204
2018	51	1.39 ^A \pm 0.027	11.28 ^A \pm 0.307	7.96 ^{EF} \pm 0.241	47	9.56 ^{BC} \pm 0.263	73.34 ^{CDE} \pm 2.273	7.57 ^D \pm 0.230
2019	157	1.22 ^{DEF} \pm 0.020	9.28 ^E \pm 0.223	7.57 ^F \pm 0.175	152	10.23 ^{AB} \pm 0.190	74.74 ^{CDE} \pm 1.645	7.34 ^D \pm 0.167
2020	178	1.26 ^{CDE} \pm 0.022	10.04 ^{CD} \pm 0.246	7.97 ^{DE} \pm 0.193	178	9.70 ^{BC} \pm 0.206	76.07 ^B \pm 1.783	7.97 ^{BC} \pm 0.180
2021	189	1.20 ^{EF} \pm 0.017	11.33 ^{AB} \pm 0.193	9.47 ^A \pm 0.152	185	8.13 ^E \pm 0.162	76.01 ^{BC} \pm 1.405	9.37 ^A \pm 0.142
2022	126	1.26 ^{DEF} \pm 0.020	8.52 ^E \pm 0.220	6.83 ^F \pm 0.172	123	9.37 ^{CD} \pm 0.185	61.50 ^F \pm 1.598	6.69 ^D \pm 0.162
2023	102	1.39 ^B \pm 0.021	9.72 ^{DE} \pm 0.231	7.08 ^F \pm 0.181	102	9.07 ^{BCD} \pm 0.194	64.96 ^{EF} \pm 1.678	7.08 ^D \pm 0.170

*N is the number of observations, Values in each column having a common superscript do not differ significantly (**P<0.01, *P<0.05)

litter size and litter weight, as well as sows producing large litters with less uniformity in body weight at birth and weaning. The litter weight at first parity was less compared to other parity and was in coincidence with the findings of Buthelezi *et al.* 2024. On the contrary, Zindove *et al.* (2013) observed that the light weight piglets have low energy reserves and capacity to maintain body temperature. Piglets born in winter had a larger litter weight, despite their low birth weight. Thus, the season favored piglet growth. This study found a substantial (P<0.01) difference in litter weight at birth and weaning by season, which was

consistent with Zindove *et al.* (2014). Because primiparous sows must mature and use the energy available for body maintenance, maturation, and the growth of the foetus, their litter weight at birth (kg) was 7.59 kg less than that of multiparous sows (14.29 kg). In contrast, multiparous sows' energy was more directed toward maintenance and production, which results in a higher rate of ovulation, as supported by the findings of Tokach *et al.* (2019).

Litter size at birth and weaning: In 2021, a larger litter size at birth and during weaning was noted (Table 1 and Table 2). There were 7.08 to 9.47 live births, with an average

Table 2. Least Mean square (\pm S.E) body weight (kg), litter weight (kg) and litter size (No.) of piglets in large white Yorkshire pigs

Effect	At birth				At Weaning			
	N*	Birth Weight	Litter weight	Litter size	N*	Weaning weight	Litter weight	Litter size
Overall mean	1341	1.28 \pm 0.007	10.49 \pm 0.073	8.23 \pm 0.057	1307	9.32 \pm 0.062	74.50 \pm 0.534	8.07 \pm 0.054
Season		**	**	**		*	**	**
Winter	302	1.22 ^B \pm 0.013	10.43 ^C \pm 0.140	8.69 ^B \pm 0.110	290	9.33 ^b \pm 0.120	77.22 ^B \pm 1.037	8.44 ^B \pm 0.105
Summer	414	1.29 ^A \pm 0.012	10.58 ^B \pm 0.137	8.09 ^B \pm 0.107	406	9.43 ^b \pm 0.115	73.85 ^B \pm 0.999	7.93 ^B \pm 0.101
SWM*	268	1.29 ^A \pm 0.014	10.73 ^A \pm 0.158	8.31 ^A \pm 0.124	263	9.53 ^a \pm 0.133	77.01 ^A \pm 1.149	8.21 ^A \pm 0.116
NEM*	357	1.32 ^A \pm 0.013	10.27 ^B \pm 0.148	7.90 ^B \pm 0.116	348	9.03 ^b \pm 0.125	70.87 ^B \pm 1.081	7.77 ^B \pm 0.109
Parity		**	**	**		**	**	**
First	234	1.25 ^C \pm 0.017	7.59 ^F \pm 0.194	6.16 ^D \pm 0.152	224	9.38 ^A \pm 0.165	55.43 ^C \pm 1.426	5.91 ^D \pm 0.144
Second	237	1.27 ^{BC} \pm 0.015	10.61 ^E \pm 0.168	8.35 ^C \pm 0.132	228	9.73 ^A \pm 0.142	79.06 ^B \pm 1.230	8.09 ^C \pm 0.125
Third	224	1.30 ^{AB} \pm 0.015	10.57 ^{DE} \pm 0.167	8.17 ^{BC} \pm 0.131	221	9.79 ^{AB} \pm 0.140	78.27 ^B \pm 1.215	8.09 ^{BC} \pm 0.123
Fourth	239	1.29 ^{AB} \pm 0.015	10.83 ^{CD} \pm 0.172	8.38 ^B \pm 0.135	237	8.81 ^{CD} \pm 0.144	72.82 ^B \pm 1.248	8.31 ^B \pm 0.126
Fifth	222	1.32 ^{BC} \pm 0.016	11.92 ^{BC} \pm 0.176	9.40 ^A \pm 0.138	218	9.05 ^{CD} \pm 0.148	83.63 ^B \pm 1.284	9.36 ^A \pm 0.130
Sixth	106	1.27 ^{ABC} \pm 0.021	12.09 ^B \pm 0.234	9.59 ^A \pm 0.184	103	8.77 ^D \pm 0.197	80.46 ^B \pm 1.706	9.38 ^A \pm 0.173
Seventh	79	1.34 ^A \pm 0.020	14.29 ^A \pm 0.227	10.64 ^A \pm 0.178	76	9.14 ^{BC} \pm 0.194	93.24 ^A \pm 1.684	10.21 ^A \pm 0.170

*N is the number of observations Values in each column having a common superscript do not differ significantly (**P<0.01, *P<0.05) Winter (Dec - Feb), Summer (May - Aug), *SWM- South West Monsoon (Jun - Aug), *NEM -North East Monsoon (Sep - Nov)

of 8.23 at birth, and 7.08 to 9.25 live births, with an average of 8.07 at weaning. At SWM, the litter size was larger and the difference was statistically significant ($p < 0.01$). From the fifth to the seventh parity, the larger litter sizes were seen at birth and during weaning. Multiparous sows require less nutrients and energy for their growth and development which explains higher ovulation rates than primiparous sows (Islas- Fabila *et al.* 2024).

A favorable correlation was found between litter size and litter weight at birth and weaning. Season has a strong ($P < 0.01$) influence on litter size (Tummaruk *et al.* 2010), and resistance to environmental changes was also attributable to the breed of the sow (Wysokinska and Kondracki, 2013). Tummaruk *et al.* (2010) found that altered endocrine secretion and stress can regulate luteal function during the early stages of pregnancy, resulting in reduced embryonic tissue implantation at day 16 and a smaller litter size (8.09 ± 0.107) at birth. The physiological status of sows, such as growth and reproductive system development, influences their parity, age, and number of farrowings (Kramarenko *et al.* 2020). Parity had the greatest effect on the number of live-born and weaned piglets (Knecht *et al.* 2015). Multiparous sows had considerably larger litter sizes ($p < 0.01$) compared to primiparous sows at birth and is consistent with the findings of Klimas *et al.* (2020) (from primiparous to second parity) and Kramarenko *et al.* (2020) (fifth to seventh parity).

The litter size at birth increased from parity 1 to parity 5 (Cechova and Tvrdon, 2006) and up to sixth parity (Skorjanc *et al.* 2007), with no significant variation between parity 2 and 8. Hoving *et al.* (2011) and found that sows' reproductive characteristics are optimal between parities 3 and 5. The litter size was larger from the fifth parity onwards, with higher body weight, which was consistent with the findings of Tantasuparuk *et al.* (2000) and Tummaruk *et al.* (2000), as well as the high uterine space during foetal development, as supported by Dekkers *et al.* (2011), who found that the number of live born piglets is an important trait that is positively correlated with the number of weaned piglets. Normally, the size of the litter and birth weight are influenced by the rate of ovulation and embryo survival. The litter size at first and second parity was small because young sows ovulate at a slower rate than older sows, which is consistent with the findings of Peters *et al.* 2010 and Zindove *et al.* 2021.

The litter size was smallest at first parity (6.16 ± 0.152) compared to other parities, which is consistent with the findings of Takai and Koketsu 2008 and Hoving *et al.* 2011). This can be due to low uterine size and insufficient space for piglet implantation and development resulting poor zygote quality and foetal mortality. Light weight piglets produced from larger litter sizes have lower survivability before weaning than average weight piglets (Ward *et al.* 2020; Zeng *et al.* 2019).

The results of the study showed that birth weight, litter size, and litter weight were significantly ($p < 0.01$) impacted by the sow's parity and season. Piglets born during the

North East Monsoon period had greater birth weights, and those born between the third and seventh parities would have larger body weights. It is, therefore, suggested to breed sows earlier than usual in favorable season and maintain them up to seventh parity or till the age of four years old.

Ethical approval: This study did not require ethical approval, or the consent of an ethics committee, as the data was collected from live animals as part of conventional farm practices.

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