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Generation-wise performance evaluation of Ghoongroo pig: An effort to improve the productivity

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ABSTRACT

Ghoongroo pig is the first recognized pig breed in India from the North Bengal and adjoining districts of Assam. This breed has been evolved through continuous breeding and selection within its native breeding tract. The present investigation aimed to evaluate the genetic performance of Ghoongroo pigs across generations, utilizing data collected over a 13-year period (2008-2021) from the Nucleus Pig Breeding Farm at the ICAR-National Research Centre on Pig in Guwahati, Assam. The analysis of productive, reproductive and carcass traits revealed continuous improvements in litter size, litter weight, weaning weight and other traits over successive generations due to selective breeding. The study highlighted the consistent genetic progress achieved through selective breeding within the Ghoongroo pig breed. The scientifically managed nucleus herd of Ghoongroo pigs at the research institute serves as a valuable repository for preserving the breed's genetic resources and acts as a conservation unit for this unique indigenous breed.

Keywords: Generation-wise performance evaluation, Ghoongroo pig, Production traits, Reproductive traits

Livestock plays a crucial role in the socio-economic upliftment of India's rural and tribal population. Livestock farming not only provides supplementary income to the farmers, but also provides nutrition in the form of their products (Bharati *et al.* 2022). India is endowed with great genetic variations among the pig breeds with a total 14 registered indigenous breeds of pigs. Pig farming is one of the most important sources of livelihood (Banik *et al.* 2022) for rural and tribal farmers, especially in North-eastern regions of India. The farmers of this region mostly rear pigs of non-descript types, although a few well-defined indigenous breeds are also available (Banik *et al.* 2013). The total population of pig in the country is 9.06 million and Assam state contributes the highest population of pigs in India with 2.10 million (20th Livestock Census 2019). Pig rearing in backyard smallholder production systems is a common practice among various tribal communities in Assam (Banik *et al.* 2020).

Ghoongroo pig is the first recognized pig breed of India with registration no. INDIA_PIG_2100_GHOONGROO_09001. The breed is native to North Bengal and adjoining districts of Assam (Bharati *et al.* 2022, Rajak *et al.* 2024a). This breed has evolved through continuous breeding and selection in their native breeding tract. Ghoongroo is medium sized , mostly black coloured, with bull dog appearance, well-known for its prolificacy and ability to sustain in low input system (Bharati *et al.* 2023). This breed is mostly maintained under scavenging system and is very docile in nature. Out of 9.06 million pigs of India, Ghoongroo pigs comprises 0.26 million which constitutes 2.9% of total pig population of India. This pig is widely utilized for crossbreeding with exotic pigs as well as for grading-up of local pigs to increase the productivity. The breeding programs of pigs mainly focus on few traits of economic importance, particularly growth and litter traits and are found to be very successful (Naha *et al.* 2016). Profitability of any pig farm depends on reproductive performance of the pigs, e.g. farrowing interval, litter traits, etc., as well as growth traits and pre-weaning mortality (Singh and Khanna 2000, Rajak *et al.* 2024b). These traits are crucial to reduce the cost of rearing and generation interval and to increase genetic gain per unit of time (Das *et al.* 2005). Ghoongroo pigs have sound reproductive efficiency and have medium production potential. These characteristics of desi pigs make them highly suitable for small-scale pig farmers, practicing low-input production systems, contributing to sustainable pig farming and livelihoods (Banik *et al.* 2022). The continuous selection in the Ghoongroo breed showed improvement in the reproduction and production traits. The present study was aimed to evaluate the generation-wise

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genetic performance of Ghoongroo pigs maintained at pig farm of ICAR-National Research Centre on Pig.

MATERIALS AND METHODS

The present study was conducted at the Nucleus Pig Breeding Farm of ICAR-National Research Centre on Pig in Guwahati, Assam. The farm is situated at latitude 26.01°N, longitude 91.34°E, and an elevation of 56 m above mean sea level (MSL) and located in sub-Himalayan north-eastern part of India. Climate of Guwahati is mildly sub-tropical with warm, dry summers from April to late May, a strong monsoon from June to September and cool, dry winters from late October to March. The area experiences an annual rainfall of 180 cm (from May to September) with an average number of 77.3 rainy days annually. While summer temperature ranges from 22 to 38°C, in winters the temperature remains between 10 to 25°C. Data of Ghoongroo pigs present in the farm during the last 13 years period (2008–2021) was used for the study.

Management practices of the animals: The farm maintains animals under organized conditions including housing, management and healthcare. Regular vaccination is practiced against various pig diseases. Animals are housed based on their sex, age, class, and physiological status. Mature boars and pregnant animals are housed in individual pens. Piglets were housed with their dam in indoor pens (12.0 ft × 10.0 ft with concrete flooring) varying from 6 to 10 piglets per pen (Banik *et al.* 2012). Pregnant sows are kept in farrowing pen one month before farrowing.

Water was made available *ad lib.* Piglets were offered starter feed (CP 24%) @ 20 g per animal from third week onwards till weaning, as per NRC recommendation (NRC 1998). The amount of ration was gradually increased by 20 g/week till it reached 80 g/piglet/d at the time of weaning (42 days). Veterinary care including deworming and vaccination against swine fever and FMD, iron injection was routinely administered. Regular health monitoring and the routine veterinary practices for prevention and prophylaxis of different diseases were monitored. The piglets were individually marked by ear tag for identification.

Recording of performance data: Data on all productive, reproductive and carcass traits of the animal were collected. The body weight at different ages up to slaughter were collected by electronic weighing balance. The litter parameters, viz. litter size and litter weight at birth and weaning were recorded. The growth parameters, viz. pre- and post-weaning growth rate were estimated. Generation-wise data were recorded to estimate the effect of selection and genetic gain. A total data of nine generations was collected and the genetic gain between two consecutive generations was estimated. However, number of observations varied among the generations due to disposal policy of the farm and occurrence of disease. The number of observations for each trait varied depending on the trait, like for litter size traits total 118 farrowing were recorded, while for individual weaning weight a total of 961 observations were recorded. Similarly, for pre- and post-weaning growth rates, 961 and 294 observations were recorded across the generation, respectively. The information about the number of records per generation is provided in the Table 1.

Breeding plan in the farm: The animals are maintained by selective breeding at the institute following strict selection parameters. Two-stage sequential selection was practiced for the purpose of selecting the superior boars. Initial selection of male (best 25%) was done based on weaning weight and finally on four-month body weight. Besides body weight, the co-litter size of the selected male population was fixed as more than 8. Whereas, selection of gilts was done based on the dam's litter size at birth (≥8), weaning weight (best 25%) and number of functional teats (at least 6 pairs). Top 3% of males and 8% of females were selected for their own replacement stock of the farm. Further, to create the variability in the (re)production traits within the existing gene-pool of the farm population, replacement with pure animals from breeding tract was done following a purposive survey and field-based performance evaluation with strict selection measures. The replacement stocks were subjected to mandatory quarantine before induction in the institute farm.

Statistical analysis: Generation-wise data was collected on (re)production and carcass traits of the Ghoongroo pigs maintained in the farm. A least square model (Harvey 1987) was used to estimate the effect of generation on different traits. Duncan's multiple range test (DMRT) as modified by Kramer (1957) was used to compare the means of different groups. The data was analyzed using Statistical Package for the Social Sciences for Windows Version 16.0 (SPSS Inc; Chicago, IL, USA). The generation-wise genetic gain of Ghoongroo pigs was estimated using the formula:

$$\text{Genetic gain (GG)} = \frac{\text{(Performance of trait in progeny generation – Performance of trait in parental generation)}}{\text{(Performance of trait in parental generation)}} \times 100$$

RESULTS AND DISCUSSION

The present study was done to evaluate the generation-wise genetic performance of Ghoongroo pigs maintained at pig farm of ICAR-National Research Centre on Pig. For the purpose, the relevant data of reproduction, production and carcass traits for nine generations of Ghoongroo pigs were collected and analyzed to know the differences among generations and genetic gain for different traits over the generations.

Effect of generations on re(production) traits: The generation-wise genetic performance of different (re) productive and productive traits of Ghoongroo pig for nine generations are given in Table 1. The litter size at birth and weaning showed significant ($P<0.05$) difference over the generations. The average litter size at birth for all the generations was 8.54±0.13 with litter weight of

Table 1. Generation-wise performance evaluation of Ghoongroo pig

Trait	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9	Pooled data over the generation
(Re)productive traits										
Litter size at birth (no. of farrowing)	7.90± 0.28^{a} (10)	7.85± 0.26^{a} (13)	8.09± 0.34^{a} (11)	8.32± 0.36^{b} (13)	8.41± 0.39^{b} (15)	8.66± 0.36^{bc} (12)	8.91± 0.39^{c} (13)	9.13± 0.42^{c} (16)	9.20±0.33^{c} (15)	8.54± 0.13 (118)
Litter weight (kg) at birth (no. of farrowing)	7.52± 0.24^{a} (10)	7.89± 0.29^{a} (13)	8.25±0.29^{b} (11)	8.50± 0.35^{b} (13)	8.69± 0.46^{b} (15)	8.91± 0.53^{bc} (12)	9.40± 0.39^{c} (13)	9.55± 0.48^{c} (16)	9.72± 0.31^{c} (15)	8.72± 0.25 (118)
Litter size at weaning (no. of weaning)	7.20± 0.36^{a} (10)	7.46± 0.42^{a} (13)	7.82± 0.38^{ab} (11)	8.00± 0.48^{b} (13)	8.13± 0.40^{b} (15)	8.17± 0.32^{b} (12)	8.38± 0.27^{bc} (13)	8.69± 0.34^{c} (16)	8.93± 0.32^{c} (15)	8.14± 0.13 (118)
Individual weaning weight (kg)(no. of weaner)	4.29± 0.61^{a} (72)	4.75± 0.40^{a} (97)	4.63±0.62^{a} (86)	5.01± 0.52^{ab} (104)	5.23± 0.75^{ab} (122)	5.50± 0.43^{b} (98)	5.51± 0.39^{b} (109)	5.75± 0.32^{b} (139)	5.73± 0.31^{b} (134)	5.16± 0.17 (961)
Feed conversion ratio	4.11± 0.29	4.22±0.25	4.15± 0.31	4.11± 0.19	4.05± 0.17	4.00± 0.33	4.02± 0.23	4.00± 0.20	3.95± 0.19	4.07± 0.06
Litter weight (kg) at weaning (no. of weaning)	32.26± 2.66^{a} (10)	35.91± 3.01^{a} (13)	36.36±2.87^{a} (11)	41.25± 3.84^{b} (13)	42.26± 3.99^{b} (15)	45.10± 3.11^{b} (12)	46.09± 2.56^{b} (13)	48.83± 3.55^{bc} (16)	50.93± 3.62^{c} (15)	42.12± 2.10 (118)
Pre-weaning growth rate (g/d) (no. of weaner)	83.45± 11.15^{a} (72)	93.62± 11.16^{a} (97)	90.26±11.69^{a} (86)	99.71± 10.28^{ab} (104)	104.92±12.63^{b} (122)	111.78±11.12^{b} (98)	111.38±10.26^{b} (109)	117.51±11.26^{b} (139)	116.61± 9.63^{b} (134)	103.25± 5.09 (961)
Post-weaning growth rate (g/d)(no of observation)	256.00±22.32^{a} (25)	265.15±23.51^{a} (38)	276.60±24.52^{a} (28)	273.65±27.96^{a} (37)	274.60±26.34^{a} (30)	278.75±28.39^{a} (28)	283.90±25.21^{a} (33)	285.15±29.61^{ab} (35)	286.95±24.26^{b} (37)	275.64±15.29 (294)
Weight (kg) at 8 months (no of observation)	55.49± 3.69^{a} (28)	57.78± 3.09^{a} (38)	59.95± 3.52^{ab} (28)	59.74± 4.29^{ab} (37)	60.15± 4.56^{ab} (30)	61.25± 3.88^{b} (28)	62.29± 3.72^{b} (33)	62.78± 4.22^{b} (35)	63.12± 4.07^{b} (37)	63.12± 4.07 (294)
Carcass traits										
Dressing percentage (%)	73.00± 2.21	74.26± 2.32	74.25± 2.22	74.58± 2.58	75.00± 3.21	75.00± 2.99	75.10± 3.01	75.00± 2.81	75.12± 2.55	74.59± 0.25
Carcass length (cm)	66.59±4.12^{a}	69.34± 4.52^{a}	71.94± 5.22^{ab}	71.69± 4.32^{ab}	72.18± 5.98^{ab}	73.50± 5.62^{b}	74.75± 4.87^{b}	75.34± 4.02^{b}	75.74± 4.31^{b}	72.34± 2.89
Back fat thickness (cm)	2.75±0.09	2.75± 0.1	2.74± 0.15	2.74± 0.12	2.74± 0.11	2.72± 0.12	2.73± 0.08	2.72± 0.10	2.72± 0.11	2.74± 0.03
Loin eye area (sq. inch)	3.26±0.11^{a}	3.40± 0.11^{a}	3.53± 0.14^{ab}	3.51± 0.13^{ab}	3.54± 0.11^{ab}	3.60± 0.22^{b}	3.66± 0.09^{b}	3.69± 0.11^{b}	3.71± 0.12^{b}	3.53± 0.06
No. of animals used for carcass data evaluation	5	7	7	10	9	8	8	10	8	72

G_1 …. G_9,= First generation and so on; Figures with different superscript differ significantly ($P<0.05$).

8.72±0.25 kg. The litter size at birth was 7.90±0.28 at first generation, whereas after continuous selection it was found to be 9.20±0.33 in ninth generation. The litter size at birth showed a continuous improvement over the generation, except at the second generation (7.85±0.26). Similarly, litter size at weaning showed significant improvement over the generation and it was found to be 7.20±0.36 in first generation, whereas 8.93±0.32 in ninth generation. The average litter size at weaning for all the generations was 8.14±0.13 with litter weight of 42.12±2.10 kg. The weaning weight of individual pigs at 6 weeks of age of ninth generation was observed as 5.73±0.31 kg. The weaning weight of individual pig improved over the generations from 3rd to 8th generation. The weaning weight in 9th generation showed slight decrease (5.75 to 5.73 kg), which may be due to the change in management condition/ feed or due to variable number of observations during the generations. The other litter traits like litter weight at birth and weaning, litter size at weaning and weaning weight also showed similar trends over the generations in the Ghoongroo pigs. The pre-weaning growth rate was higher in later generations which is in corroboration with the reports of Chakurkar *et al.* (2021). Significant increase was also observed in the weight at weaning and slaughter age of 8 months. There was no significant change in Feed conversion Ratio (FCR) in the farm. The analysis also indicated that pre-weaning growth rate and weaning weight both decreased in G_3 which is obvious due to positive correlation between two traits. The decrease in performance of these traits in 3rd generation might be due to the detrimental environmental effect on these traits and management issues that hindered performance traits along with body growth (Chakurkar *et al.* 2021).

Effect of generations on carcass traits: Four major carcass traits, viz. dressing percentage, carcass length (cm), back fat thickness (cm) and loin eye area (sq. inch) were considered for the present study. The dressing percentage and back fat thickness did not show any response to the selection. It implies that selective breeding efforts did not significantly impact these specific traits in the pigs under study, which might be due to the different environmental factors and management practices or due to less intense selection. If environmental factors were not controlled or varied significantly, they could mask the genetic effects of selection (Patience *et al.* 2015). However, significant ($P<0.01$) improvement of body length and loin-eye area over the generations showed positive response to selection.

The perusal of analysis showed a consistent increase in desired performance among reproduction and growth traits and some of the carcass traits (body length and loin-eye area). However, in majority of traits, no significant improvement was observed after seventh generation of selective breeding which may be due to exhaustion of additive genetic variances for the traits or due to plateau effect or less intense and automatic selection rather than the deliberate selection (Chakurkar *et al.* 2021). Graphical representation of the generation-wise genetic performance of Ghoongroo pig is given in Fig. 1.

Present study corroborates to the study performed in different breeds of pigs under Indian conditions. Banik *et al.* (2013) reported weaning weight of 5.69±0.19 kg at 6 weeks of age during 2013 at the same farm, which showed an improvement due to selection as reported (5.73± 0.31 kg) in the present investigation. The generation interval had a significant effect on body weights at all ages in crossbred pigs and it was found that the piglets born in first generation had higher growth (Naha *et al.* 2017). However, they found that the piglets born in second generation had higher litter traits compared to the first generation, which may be due to the different environmental factors. Chakurkar *et al.* (2021) had also observed significant difference ($P<0.01$) in body weights among different generations in crossbred pigs where animals belonging to latest generation showed maximum body weights indicating ideal selective breeding

Table 2. Generation-wise genetic gain of Ghoongroo pigs

Traits	$GG_{1\text{-}2GEN}$	$GG_{2\text{-}3GEN}$	$GG_{3\text{-}4GEN}$	$GG_{4\text{-}5GEN}$	$GG_{5\text{-}6GEN}$	$GG_{6\text{-}7GEN}$	$GG_{7\text{-}8GEN}$	$GG_{8\text{-}9GEN}$
(Re)productive traits								
Litter size at birth (nos.)	-0.63	3.06	2.84	1.08	2.97	2.89	2.13	0.22
Litter weight at birth (kg)	4.92	4.56	3.03	2.24	2.53	5.50	1.60	1.78
Litter size at weaning (nos.)	3.45	4.27	2.43	1.37	0.37	3.07	3.21	2.65
Weaning weight (kg)	10.72	-2.53	8.21	4.39	5.16	0.18	4.36	-0.35
Feed conversion ratio	2.68	-1.66	-0.96	-1.46	-1.23	0.50	-0.50	-1.25
Litter weight at weaning (kg)	11.31	1.25	13.45	2.45	6.72	2.20	5.94	4.30
Pre-weaning growth rate (g/d)	12.19	-3.60	10.47	5.22	6.54	-0.36	5.51	-0.77
Post-weaning growth rate (g/d)	3.57	4.32	-1.07	0.35	1.51	1.85	0.44	0.63
Weight at 8 months (kg)	4.13	3.76	-0.35	0.69	1.83	1.70	0.79	0.54
Carcass traits								
Dressing percentage (%)	1.73	-0.01	0.44	0.56	0.00	0.13	-0.13	0.16
Carcass length (cm)	4.13	3.76	-0.35	0.69	1.83	1.70	0.79	0.54
Back fat thickness (cm)	0.00	-0.36	0.00	0.00	-0.73	0.37	-0.37	0.00
Loin eye area (sq. inch)	4.13	3.76	-0.35	0.69	1.83	1.70	0.79	0.54

$GG_{1\text{-}2GEN}$…. $GG_{1\text{-}2GEN}$, Genetic gain from first to second generation and so on.

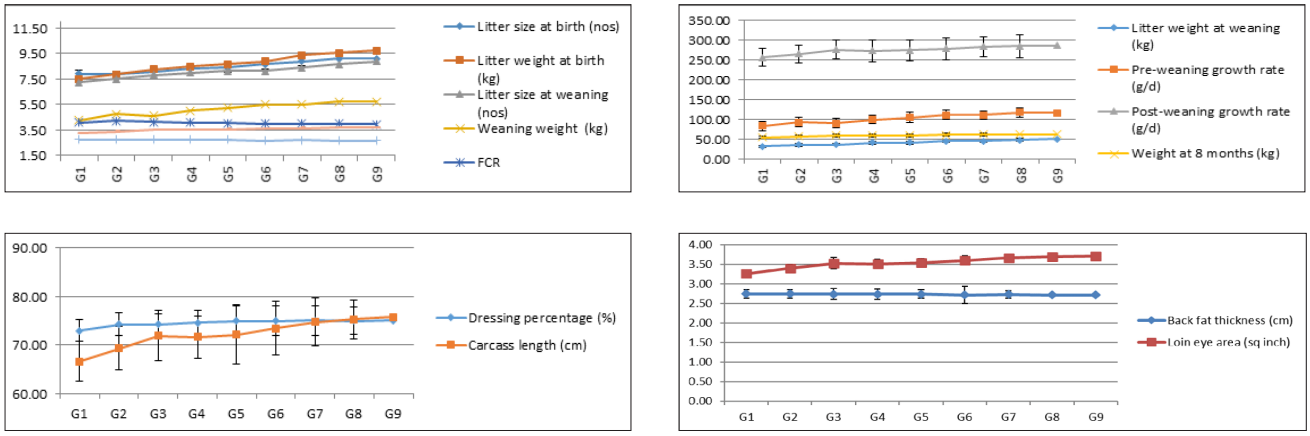

Fig. 1. Graphical representation of the generation-wise genetic performance of Ghoongroo pig (X-axis denotes the generation number while Y-axis represents the value of corresponding traits).

in the herd.

Generation-wise genetic gain of Ghoongroo pigs: Phenotypic selection differential and heritability were considered as prime factors to estimate the response to selection of different economic traits over the generation. The generation-wise genetic gain of Ghoongroo pigs for all the traits were estimated and are presented in Table 2. The genetic gain for almost all the traits showed the consistent genetic gain as a response to selection. However, high genetic gain was observed during initial generations of selection and in later generation it was less due to the fact that in initial generations there were high genetic variance among the traits which subsequently decreased due to selection in continuous generations. The proper selection and management practices, along with better adaptability in successive generations could have helped in achieving higher genetic gain in overall performances. The decline in the feed conversion ratio over the generations showed desirable improvement of feed efficiency and response to selection.

The generation-wise performance evaluation of Ghoongroo pigs showed a positive trend of selection and signified the efficiency of selection in the breeding herd. The reproductive and growth performances of this prized indigenous pig breed has continuously improved over the generations. This breed is well-adapted to the hot and humid climate without hampering their growth and reproductive potentials. The response to selection at later generations showed low improvement and most of the traits differed non-significantly after 7th generation. The additive genetic variance among the population seems to be less or exhausted. For introducing more genetic variations, new animals should be introduced in the herd to get more improvement in the breed. Collectively, the results of the current study indicated that there is a wider scope of this breed for commercial pig farming due to its high re(production) performance and its ability to thrive well in the prevailing hot humid tropical climate with potential for high economic return.

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